Report of the Biological Evaluation of the Boll Weevil Eradication Trial Conducted in Virginia and North Carolina 1977-1980

REPORT OF THE
BIOLOGICAL EVALUATION OF THE
BOLL WEEVIL ERADICATION TRIAL
CONDUCTED IN
NORTH CAROLINA AND VIRGINIA
1977-1980

prepared by

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for

Biological Evaluation Team

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The Boll Weevil Eradication Trial (BWET) began in 1978 and will continue through the 1980 crop season. In 1977, base line data for the Biological Evaluation of BWET in North Carolina were collected in Cleveland County (8 fields), Anson County (8 fields), Scotland and Robeson counties (8 fields), Chowan County (6 fields), and Northampton, Halifax and Edgecombe counties (18 fields). Because of dry weather and heavy bollworm infestations in 1977, production of cotton in Anson County was severely reduced in 1978. Therefore, collection of field data was discontinued in Anson County after the 1977 crop season. Locations of monitored areas are shown in Figure 1.

In 1978 the number of fields monitored was increased to 219 fields. Twenty-four of these fields were monitored intensively (semi-weekly).

(1) In the Evaluation Area of the Eradication Trial (excluding Chowan County), 126 fields were monitored including 8 intensively monitored fields. Fields were located in Northampton, Halifax, Hertford, Bertie, Edgecombe and northern Nash counties.

(2) In the Buffer Area (Dunn area) of the BWET, 35 fields were monitored including 4 intensively monitored fields. The Buffer Area is located in Sampson, Harnett, Johnston, Cumberland, Wilson and southern Nash counties.

(3) In Chowan County, 19 fields were monitored including 4 intensively monitored fields. Chowan County is an isolated cotton growing county on the eastern edge of the Evaluation Area and was used as a Methods Development Area by the APHIS operational group implementing the BWET.

(4) In Scotland and Robeson counties, 19 fields were monitored including 4 intensively monitored fields. Scotland and Robeson counties are located outside the Eradication Trial Area in the southern Coastal Plain area of North Carolina and represented one of two Current Insect Control Practice areas.

(5) Cleveland County, the second of two Current Insect Control Practice areas, is located in the western Piedmont or foothills of North Carolina. In Cleveland County, 20 fields were monitored including 4 intensively monitored fields.

In 1979 there were 206 fields monitored in the Boll Weevil Eradication Trial. Of these, 26 were monitored intensively (semi-weekly).

(1) In the Evaluation Area of the Eradication Trial, 115 fields were monitored including 10 intensively monitored fields. As in 1978, these fields were located In Northampton, Halifax, Hertford, Bertie, Edgecombe and northern Nash counties.

(2) In the Buffer Area (Dunn area) of the BWET, 21 fields were monitored including 4 intensively monitored fields. The Buffer Area is located in Sampson, Harnett, Johnston, Cumberland, Wilson and southern Nash counties.

(3) In Chowan County, 28 fields were monitored including 4 intensively monitored fields. As in 1978, Chowan County was used as a Methods Development area by the APHIS operational group implementing the BWET.

(4) In Scotland and Robeson counties, 21 fields were monitored including 4 intensively monitored fields. These counties represent one of two Current

Insect Control Practice areas.

(5) In Cleveland County, the second of two Current Insect Control Practice areas, 21 fields were monitored including 4 intensively monitored fields.

In 1980 there were 155 fields monitored in the Boll Weevil Eradication Trial. Of these, 24 were monitored intensively (semi-weekly).

(1) In the Evaluation Area of the Eradication Trial, 68 fields were monitored including 8 intensively monitored fields. As in 1978 and 1979, these fields were located in Northampton, Halifax, Hertford, Bertie, Edgecombe and northern Nash counties.

(2) In the Buffer Area (Dunn area) of the BWET, 21 fields were monitored including 4 intensively monitored fields. The Buffer Area is located in Sampson, Harnett, Johnston, Cumberland, Wilson and southern Nash counties.

(3) In Chowan County, 25 fields were monitored including 4 intensively monitored fields. As in 1978 and 1979 Chowan County was used as a Methods Development area by the APHIS operational group implementing the BWET.

(4) In Scotland and Robeson counties, 20 fields were monitored including 4 intensively monitored fields. Scotland and Robeson counties are located outside the Eradication Trial Area in the southern Coastal Plain Area of North Carolina and represented one of two Current Insect Control Practice areas.

(5) Cleveland County, the second of two Current Insect Control Practice areas, is located in the western Piedmont or foothills of North Carolina. In Cleveland County 21 fields were monitored including 4 intensively monitored fields.

As indicated above, cotton is grown in widely separated areas in North Carolina as a part of different agricultural crop production systems.

In the Coastal Plain of North Carolina, major crops include corn, tobacco, soybeans, peanuts and cotton. Of these, the large corn plantings (Figure 2) in the Coastal Plain cause serious bollworm problems in cotton during late July and August. Almost 2 million acres of corn are planted in North Carolina. As shown in Figure 2, a high percentage of this acreage is planted in the Coastal Plain. Large populations of bollworms (corn earworms) develop in the corn ears during July and August and emerge to infest cotton in mid- to late-July (southern areas) and August (northern areas). The severity of the bollworm attacks on cotton, in part, appears to be related to the size of the corn acreage planted within the areas where cotton is grown. The severity of the bollworm infestations in the Buffer Area and Scotland-Robeson counties is more intense because of larger corn plantings than in more northern areas such as Halifax and Northampton counties. A large corn acreage is planted annually in these areas but is substantially less than in the central and southern Coastal Plain counties. By contrast, in Cleveland County in the western Piedmont Area of North Carolina, growers plant a much smaller corn acreage. Here the corn is planted later, therefore, earworm populations emerge later to attack cotton and soybeans. The beneficial insect population in Cleveland County cotton fields was large enough to provide adequate suppression of bollworm infestations during 1977, 1978 and 1979. In 1980 fields receiving inseason boll weevil controls with organophosphate insecticides experienced reductions in beneficial populations and required additional insecticide treatments for bollworm control.

Dynamic crop information such as weather, fruiting, missing fruiting forms, plant height, rooting depth and number of main stem nodes were recorded. Beneficial and pest arthropod populations were monitored with weekly estimates of populations and damage in the fields. The size of

beneficial arthropod populations was estimated by sampling with a D-Vac insect collecting machine. The sample was returned to the laboratory where the numbers of each species (or a group of species) were determined.

Static crop information such as planting date, cultivar, row spacing, soil types, peripheral ecosystems, insecticide applications, and yields were recorded.

The optical character reader (OCR) system was used for entering onto magnetic computer tape approximately 1/2 of the data collected for the Biological Evaluation of the Boll Weevil Eradication Trial. Key-to-tape was used for entering the remainder. Optical character reading offers a viable alternative to keypunching (or key-to-tape entry) and is faster. In addition, the OCR form is more convenient for visual examination than a keypunching form because the latter uses codes for insect names and sampling methods. Each 8 1/2" x 14" OCR form provides a concise record of all scouting data for 1 site for 1 day.

From the magnetic tape, data were stored on-line in computer memory. After the data files were edited, dual backups were created either on tape or private disc-packs. Files were accessed and programs submitted from our own terminals connected via acoustic couplers to the host computer at the Research Triangle Park. Jobs requiring more than 10 pages of printout were routed to the high speed printer at the N. C. State University Computation Center.

The Boll Weevil Eradication Trial (BWET) in North Carolina and Virginia was conducted concurrently with the Optimum Pest Management Trial (OPM) in Panola County, Mississippi. The objectives of the Biological Evaluation of these Trials are as follows:

A. To evaluate the degree of biological success of the Boll Weevil

Eradication (BWE) Trial and the Optimum Pest Management (OPM) Trial.

B. To develop the relationships of the detrimental and beneficial cotton arthropods to the environment, cultural practices, needs for insecticide applications and resulting yield.

C. To measure the impact under BWE, OPM and Current Insect Control (CIC) of the boll weevil, bollworms, and predators and parasites on pesticide usage and cotton yield.

D. To provide inputs needed to estimate and compare current and future beltwide biological impacts of BWE, OPM and CIC procedures by regions.

This report of the Research Team conducting the Biological Evaluation of the Boll Weevil Eradication Trial will consider objective B--relationships of detrimental and beneficial cotton arthropods to the environment, cultural practices, need for insecticide applications and resulting yield. The other objectives (above) will be considered in the overall report of the Biological Evaluation Team.

Varieties, Row Spacing, Plant Populations and Soils

Seven varieties of cotton were planted in the intensively monitored biological evaluation fields from 1977 through 1980 (Table 1). The most frequently planted variety was Coker 310^{R}. During the period of 1977-1979 a trend away from Coker toward McNair 220^{R} appears to have developed. However, this trend leveled off in 1980 with Coker 310 still being the 4 to 1 favorite. Shorter season varieties appear to be a better choice for North Carolina cotton growers, especially in those areas of the state that experience a shorter growing season such as the northern part of the Evaluation Area and Cleveland County.

The row spacings associated with the intensively monitored fields are presented in Table 2. The 40" row was the most common spacing in Cleveland,

Scotland and Robeson counties and in the Buffer Area. In Chowan County and the Evaluation Area 38" and 36" rows, respectively, were the most common spacing. These differences, primarily, reflect equipment adjustments for other crops such as tobacco and peanuts rather than a preferred spacing for cotton. Plant populations were monitored several times during the growing season. The averages of the counts taken in July and August are presented in Table 3. The plant populations in 1977 were somewhat low because of the very hot and dry conditions.

North Carolina soil types vary widely, especially within the Piedmont counties. Soils in the Coastal Plains are more homogenous. In some instances, several soil types may be represented in a single field. Soil types for sample fields were determined from county soil survey maps and are listed in Table 4.

Table 1. Cotton cultivars, North Carolina, 1977 fields, and 1978, 1979 and 1980 intensively sampled fields.

Year	No. of fields planted in Coker 201	Coker 304	Coker 310	McNair 220	McNair 235	McNair 612	Earlycot 31
			Evaluation Area				
1977	2		16				
1978			8				
1979		1	5	4			
1980		3	3[1/]	2[2/]	1		
			Buffer Area				
1978			4				
1979			4				
1980			4				
			Chowan County				
1977			6				
1978			4				
1979		1	2	1			
1980			4				
			Scotland-Robeson Counties				
1977	2		5			1	
1978			2	1		1	
1979		1		3			
1980			3	1			
			Cleveland County				
1977	7	1					
1978	2	1					1
1979		3	1				
1980				1	3		

[1/] Mixed with McNair 220

[2/] Mixed with Coker 310

Table 2. Row spacing in 5 areas of North Carolina, 1977 fields and 1978, 1979 and 1980 intensively sampled fields.

YEAR	42	40	39	38	37	36	N/A
				Evaluation Area			
1977		1	1			16	
1978						7	1
1979						10	
1980						8	
				Buffer Area			
1978		4					
1979		4					
1980		4					
				Chowan County			
1977				6			
1978		1		3			
1979		1	1	1	1		
1980		1		2		1	
				Scotland-Robeson Counties			
1977		6	2				
1978	1	2		1			
1979		2		2			
1980		4					
				Cleveland County			
1977		7	1				
1978		4					
1979		4					
1980		3		1			

Table 3. Plant populations in 5 areas of North Carolina, 1977 fields and 1978, 1979 and 1980 intensively sampled fields.

Year	No. of fields with per acre plant populations of					
	10,000 to 20,000	20 000 to 30,000	30,000 to 40,000	40,000 to 50,000	50,000 to 60,000	Over 60,000
			Evaluation Area			
1977	4	9	4			
1978		4	1		1	2
1979		2	5	1		2
1980		2	3	1	2	
			Buffer Area			
1978		2	2			
1979		3	1			
1980			2		2	
			Chowan County			
1977		4	1	1		
1978	3			1		
1979		1	2	1		
1980		1	2	1		
			Scotland-Robeson Counties			
1977	1	1	3	3		
1978		1		3		
1979		1	1	1	1	
1980			3	1		
			Cleveland County			
1977	3	2	3			
1978		1	1	2		
1979				2	2	
1980			4			

Table 4. Soil types in 5 areas of North Carolina, 1977 fields and 1978, 1979 and 1980 intensively sampled fields.

	Chowan				Evaluation				Buffer				Scotland-Robeson				Cleveland			
	1977	1978	1979	1980	1977	1978	1979	1980	1977	1978	1979	1980	1977	1978	1979	1980	1977	1978	1979	1980
Norfolk-Goldsboro-Faceville										4	2	4								
Marlboro-Norfolk-McColl													4	2	1	4				
Norfolk-Rains-Goldsboro													1	1						
Norfolk-Wagram-Rains-Bibb					3	4	4	4												
Goldsboro-Rains					2	1														
Norfolk-Orangeburg					4	2	4													
Conetoe-Wando-Dragston	3	2	2	4																
Cecil-Pacolet-Appling																	4	3		4
Rains-Lynchburg-Goldsboro														1	2					11
Wicham-Buncombe-Altavista					2	1		4												
Bladen-Lenoir-Craven		1	2																	
Dorovan-Johnston	2	1																		
Pacolet-Madison-Cevil																	3	1	4	
Rains-Norfolk-Goldsboro											2				1					
Norfolk-Aycock-Wagram					1		2													
Craven-Leaf-Lenoir	1				1															
Grover-Madison-Wedowee																	1			
Norfolk-Wagram-McColl					1								2							
Lynchburg-Rains-Norfolk					2															
Wickham-Roanoke-Altavista-Molena					2															
Johns-Lumbee													1							

1978 Intensively Sampled Fields

Evaluation Area: Weekly accumulations of rainfall in the Evaluation Area are shown in Figure 3. Rainfall appeared adequate during June, July and early August. However, during late August, rainfall appeared deficient. Limited rainfall during September and October permitted the crop to open normally without apparent loss of yield to boll rot.

The average planting date of the sampled fields was May 10. Squaring began in mid-June and peaked about August 1. As a result of excellent boll set during late July and August and because of a moisture deficiency in late August, there was a cessation of squaring in late August with only a small number of squares present per acre for the remainder of the crop season (Figure 3). As indicated, growers applied an average of 68 pounds of nitrogen per acre to the sampled fields which yielded an estimated 740 lbs. of lint per acre.

As shown in Figure 4, an average of 10.75 insecticide treatments were applied during 1978 to the intensively sampled fields in the Evaluation Area. Of these, 5.6 were applied during September and October for the suppression of diapausing populations of boll weevil. Numbers present during mid- and late-season did not require insecticide treatments to prevent damage. During 1978, the APHIS operational group was responsible for scouting for damaging infestations of bollworms (and other insects) and applying recommended insecticides for their control. Fields were scouted twice weekly from late July until early September. Insecticide treatments were applied when the number of larvae exceeded the recommended treatment threshold. Initially an ovicide, chlordimeform, was applied to 25% of the fields where large number of bollworm eggs were deposited. Subsequently, an average of 1 application of pyrethroid insecticide was made near August 15 to kill

populations of small larvae. Subsequently, methyl parathion, alone or in combination with toxaphene or methomyl (Lannate), was applied at 5-day intervals until the damaging infestations were no longer present and/or the crop was mature. Approximately 5.2 insecticide treatments (Table 5) were applied for bollworm control.

Beneficial insect populations (Figure 4) were present in moderate to large numbers in the sampled fields. As expected, they declined rapidly when insecticide applications were initiated in mid-August.

As shown in Figure 5, insecticide treatments effectively controlled the infesting bollworms. However, there were some damaged bolls as insecticide treatments began in mid-August. The peak damage to squares or bolls did not exceed 7%.

Buffer Area: Weekly accumulations of rainfall in the Buffer Area are shown in Figure 6. Rainfall appeared adequate during June, July, and early August. However, during late August rainfall appeared deficient as reported previously for the Evaluation Area. More rainfall occurred during September and October in the Buffer Area than in the Evaluation Area. However, this rainfall occurred in thundershowers of short duration and apparently did not cause a yield loss because of boll rot. The average planting date was May 12 for sampled fields. Squaring began in mid-June and peaked near August 10. As a result of excellent boll set during late July and August and because of a moisture deficiency in late August, there was a cessation of squaring in late August. However, because of September rainfall, squaring resumed during September. As indicated, growers applied an average of 68 pounds of nitrogen to the sampled fields which yielded an estimated 980 pounds of lint per acre.

As shown in Figure 7, a total of 13.0 insecticide treatments were

applied during 1978 to the intensively sampled fields in the Buffer Area. These insecticide treatments were applied to severe bollworm populations which persisted from late July until mid-September. As shown in Figure 7, organophosphate insecticides with or without toxaphene (an average of 9.47 applications) represented three-fourths of the insecticide treatments with methomyl, pyrethroids, and chlordimeform making up the remainder of the treatments. As in the Evaluation Area, the APHIS operational group was responsible for scouting for damaging infestations of bollworms (and other insects), and for applying recommended insecticides for their control. A 5-day interval insecticide treatment schedule was maintained during 1978 in the Buffer Area. Beneficial insect populations, as expected, were reduced to low levels during the insecticide treatment period.

As shown in Figure 8, insecticide treatments were effective against bollworm infestations in the sampled fields. However, under the intense population pressure, some square and boll damage occurred during July and late August, respectively. Boll damage peaked at about 12% in late August. However, in spite of the observed boll damage, growers produced record yields.

Chowan County: Weekly accumulations of rainfall in Chowan County are shown in Figure 9. Rainfall during June, July, and early August appeared adequate. However, rainfall was deficient during late August and September. More than 4 inches of rain occurred near October 1. The dry weather in September and most of October permitted the crop to open without apparent loss of yield to boll rot.

The average planting date of the sampled fields was May 13. Squaring began in mid-June, peaked during late July and declined sharply in early August. As a result of a mid-August rain (1.2 inches), squaring increased

briefly near September 1 and then declined sharply before September 15. Excellent boll set occurred during late July and August. Growers applied an average of 70 pounds of nitrogen per acre to the sampled fields which yielded an estimated 723 pounds of lint per acre.

As shown in Figure 10, a total of 11.75 insecticide treatments were applied. Chowan County, as previously mentioned, was a Methods Development Area used by the APHIS operational group. APHIS personnel applied 5 early season treatments of diflubenzuron (0.06 lb. per acre) followed by an application of azinphosmethyl (0.25 lb. per acre) for the elimination of the incipient overwintered boll weevil infestation present. Therefore, 6 of the 11.75 insecticide treatments were applied for the eradication of this incipient boll weevil infestation. During 1978, no live weevil forms (adults or immature stages) were detected in the sampled fields. The remaining insecticide treatments (an average of 5.75) were applied for the control of bollworm infestations. Of these 5.75 treatments, an average of 5.23, were organophosphate insecticides alone or in combination with toxaphene plus an average of .52 treatments of methomyl. As shown in Figure 10, bollworm larvae increased to more than 15,000 per acre about August 25 but were brought under control by the insecticide treatments. Peak boll damage of nearly 25% occurred the last of August. Negligible infestations of bollworms were present during September.

Beneficial insect populations exceeded 22,000 per acre in late July but declined rapidly as insecticide treatments were initiated.

As shown in Figure 11, bollworms damaged some 30,000 bolls per acre in late August (approximately 25% damage). Apparently, damage was to small bolls which abscised and not found in subsequent observations.

Scotland-Robeson Counties: Scotland and Robeson counties represent 1 of 2 Current Insect Control practice areas located outside of the Boll Weevil

Eradication Trial Area. Rainfall during June and July (Figure 12) was excellent and resulted in heavy squaring during late June and July. The rate of squaring decreased rapidly during August as boll set accelerated. Limited rainfall in late August and September reduced squaring and boll set at that time as shown in Figure 12.

As indicated, growers applied 22 lbs. of nitrogen per acre to the sampled fields at planting plus an additional 55 lbs. on July 3. The average yield was estimated to be 734 pounds of lint per acre.

As shown in Figure 13, an average of 10.75 insecticide treatments were applied for control of bollworm infestations. Since all insect control practices (including scouting) were under the direct supervision of growers, there was considerable variability in the number of insecticide treatments applied and effectiveness of treatments between fields. One grower who applied 9 poorly timed treatments appeared to have suffered a significant yield loss to a heavy bollworm infestation. Insecticides applied to these fields included pyrethroids, chlordimeform, organophosphates, toxaphene, and methomyl (Figure 13). As shown in Figure 14, one field was heavily damaged by bollworms which is indicated by damage to squares in late July and early August and to bolls in mid-August. Beneficial insect populations were low after July 15 when insecticide treatments began for bollworm control. Similarly, a small boll weevil infestation was observed in mid-July but was not detected after the intensive insecticide treatments began.

In spite of the severe bollworm damage in one of the four sampled fields, yield estimates averaged 734 pounds of lint per acre.

Cleveland County: Cleveland County was 1 of 2 Current Insect Control practice areas located outside of the Boll Weevil Eradication Trial Area. Rainfall appeared adequate throughout the growing season (Figure 15) with

limited rainfall occurring during September and October. Harvest weather was excellent, thus boll rot did not appear to reduce yields. The average planting date of May 20 was later than usual and could have influenced yields. Squaring was later than reported in other areas and peaked in early August. Excellent rainfall in late July and early August appeared to extend the squaring period which did not decline sharply until early September. Boll set did not begin until early August and continued well into September.

Cleveland County is located in the western Piedmont area of North Carolina where much of the land is in forests and pastures. As a result, excellent beneficial insect populations entered cotton fields early in the growing season and were present throughout late June, July and August. However, as the number of squares decreased in September and cotton matured, the size of the beneficial insect population also decreased. The beneficial insect population decline was moderate with the mid-September levels exceeding 7000 per acre.

As shown in Figure 16, low density boll weevil populations were detected during July and August. However, they did not cause economic damage in the sampled fields. Similarly, low density bollworm populations appeared to have been suppressed below the economic threshold by the beneficial insects which were present. No insecticide treatments were applied for boll weevil or bollworm control during 1978. As shown in Figure 17, bollworms damaged a relatively small number of bolls per acre and apparently caused little if any loss in yield.

As stated earlier, this late planted crop had a delayed fruiting period. As a result, the estimated yield was only 464 pounds of lint per acre even though rainfall was excellent and insect damage minimal.

1979 Intensively Sampled Fields

Evaluation Area: Rainfall in the Evaluation Area varied from field location to field location particularly during June, early July and August. Rainfall appeared to be deficient at some of the sampled fields. As a result, the squaring of plants was somewhat reduced when compared with 1978. Squaring began in late June, peaked about August 1, and declined gradually during August so that relatively few squares per acre were present by early September.

As a result of a hurricane which passed through North Carolina in early September, an average of 8.07 inches of rain fell at the sampled fields in the Evaluation Area. In addition to this heavy rainfall, extended periods of cloudy weather and moderate rainfall during September and October were conducive to boll rot during the boll opening period and appeared to cause a yield reduction.

As shown in Figure 19, an average of 1.8 insecticide treatments (pyrethroids) were applied for the control of bollworm infestations. In 1979, the APHIS operational group scouted all cotton fields twice weekly from late July until early September. Individual growers or spray group leaders determined the insecticide to be applied and time of application based upon recommendations of the North Carolina Agricultural Extension Service. Low numbers of boll weevil feeding and egg punctures were observed during the release of sterile boll weevils in early July. However, no reproducing boll weevil forms were observed at any time during the growing season in the Evaluation Area.

Beneficial insects were abundant until insecticide treatments were initiated for bollworm control during August (Figure 19). Insecticide treatments appeared to prevent serious damage to bolls (Figure 20).

The average planting date of April 24 was much earlier than in 1978. However, a cool, wet May and early June did not permit the crop to grow well. Therefore, initiation of squaring was delayed until late June. Yields appeared to have been reduced somewhat by the spotted rainfall pattern during June and August. Yield losses also resulted from boll rot because of unfavorable weather during the harvest season. As indicated previously, bollworm infestations appeared lighter than in 1978. Estimated yields averaged 511 pounds of lint per acre in the sampled fields.

Buffer Area: Weekly accumulations of rainfall in the Buffer Area are shown in Figure 21. Rainfall appeared adequate in June and July, but a 3-week rainless period extending from late July to near August 20 caused a rapid decline in squaring between August 10 and August 20 (Figure 21). Boll set was excellent during late July and August and was improved by 1.49 inches of rainfall about August 20. Rainfall during September was heavy. (A hurricane passed through North Carolina in early September.) Extended periods of rainfall during September and October caused a yield reduction because of boll rot.

A total of 12.75 insecticide treatments were applied in the Buffer Area in 1979 as shown in Figure 22. An average of 4.25 of these were applied for the control of diapausing boll weevils. In addition, an average of 1 application of diflubenzuron was applied by the APHIS operational group for the suppression of overwintered boll weevils. The other 7.5 insecticide treatments were applied for bollworm control. In 1979 the APHIS operational group scouted all cotton fields twice weekly from early July until early September. Individual growers or spray group leaders determined the insecticide to be applied and the time of application based upon recommendations of the North Carolina Agricultural Extension Service.

Chlordimeform was applied during late July and early August where fields had large numbers of eggs deposited by infesting moths. Subsequently, an average of 5.25 applications of pyrethroid insecticides were applied during August and early September to control bollworm infestations.

Beneficial insect populations were estimated to be between 20,000 and 22,000 per acre during July prior to the application of the pyrethroid insecticide. When these treatments were initiated, populations of beneficial insects declined rapidly as expected. As shown in Figure 23, some damage to bolls was caused by infesting bollworm larvae.

A low number of boll weevil feeding punctures were observed during the release of sterile boll weevils during early July. One sterile egg laid by a released sterile female was also collected on July 11. (Egg was pink in color because of Calco oil red dye fed to sterile weevils in the larval stage at the Gast Rearing Laboratory at Mississippi State, Mississippi.) No reproducing weevil forms were observed in the sampled fields.

The average planting date for intensively sampled fields in the Buffer Area was April 26. Rainfall appeared to be nearly adequate except for a short period during mid-August. An average of 7.5 insecticide treatments (Table 5) for bollworm infestations appeared to provide adequate control except for some boll damage in late August. Heavy rains during the harvest season likely reduced yields. However, sampled fields had an average estimated yield of 760 pounds of lint per acre.

Chowan County: Chowan County was used as a Methods Development Area by the APHIS operational group to test the effectiveness of microbial insecticides against the bollworm. All cotton in the County was included in this test and was scouted by APHIS. The intensively sampled fields were untreated check fields used in this county-wide experiment.

Weekly accumulations of rainfall in the intensively sampled fields is shown in Figure 24. A very dry June resulted in delayed squaring and an abnormally depressed squaring curve. However, rainfall in July and August was excellent with setting of bolls occurring in late July and August. Heavy rainfall occurred during September and October causing some boll rot and subsequent yield losses.

Boll weevils were not detected in Chowan County in 1979. Beneficial insects were present in large numbers (up to 50,000 per acre) during July and the first part of August. However, beneficial insect populations declined to approximately 10,000 per acre in late August and early September even though no insecticide treatments were applied. As shown in Figure 25, heavy bollworm infestations occurred during August and early September. These bollworm infestations damaged more than 30,000 bolls per acre in late August (Figure 26) but damage subsided during September.

A yield of 481 lbs. of lint per acre appears to reflect inadequate rainfall in June, poor harvest weather, and a heavy bollworm infestation during August and early September.

Scotland-Robeson Counties: Scotland and Robeson counties represent 1 of 2 Current Insect Control practice areas located outside of the Boll Weevil Eradication Trial Area. Rainfall during the harvest period was excessive and probably resulted in a loss of yield to boll rot.

Squaring began in mid-June, peaked in mid-July, and declined rapidly during late August. Boll set began in late July and continued into late August. As in 1978, all insect control practices (including scouting) were under the direct supervision of growers. An average of 7.53 insecticide treatments per acre were applied by growers (Figure 28). As shown, 4.01 treatments were pyrethroid, 1.32 treatments were chlordimeform and 2.20

treatments were organophosphates alone or in combination with toxaphene. While treatments were initiated primarily for bollworm control, boll weevils were present in fields during mid-July and treatments applied for bollworms effectively controlled boll weevils as well. If treatments had not been initiated for bollworm control, it appears that they would have been required for boll weevil control. Interestingly, growers began treating with pyrethroid insecticides during July and then switched to chlordimeform and organophosphate materials during late August and early September.

An average yield of 532 pounds of lint per acre in the intensively sampled fields reflects the widely separated rain showers in the fruiting period of the crop and the poor harvest weather. In some fields yields were probably reduced by late season boll weevil populations.

Cleveland County: Cleveland County was 1 of 2 Current Insect Control practice areas located outside of the Boll Weevil Eradication Trial Area. Rainfall appeared deficient during most of the growing season (Figure 30). Weekly rainfall occurred frequently during July and August. Weekly accumulations were less than 1/2 inch except during the 2nd and 4th weeks in July where .83 and .57 inches fell, respectively. As a result of a very dry June, squaring was delayed until July and beginning of boll set until late July which resulted in a very short boll set period when compared to the boll set period in other cotton growing areas in North Carolina. While significant rainfall occurred during the harvest season, it was much less than in other cotton growing areas of North Carolina.

After mid-August, sizeable boll weevil populations developed in the sampled fields. However, because the crop was late and yield prospects poor, growers did not apply insecticides to control this infestation. Since insecticides were not applied for boll weevil control, beneficial insect

populations remained high through August (Figure 31), and provided effective control of the bollworm population. Damage to squares and bolls was negligible (Figure 32).

A poor yield of 276 pounds of lint per acre was the result of limited rainfall and cool weather during June. Limited rainfall during July and August also had an adverse effect. Late developing boll weevil populations also reduced yields.

1980 Intensively Sampled Fields

Evaluation Area: Rainfall in the Evaluation Area was severely limited during late July and August. Southern areas were less affected by drought than the northern sections. Some fields in the north received less than .25 inches of total rainfall during July and August. An average of 1.17" of rainfall occurred in the intensively sampled fields between July 21 and September 3 (Figure 33). As a result of the limited moisture, combined with the abnormally hot temeratures, squaring was reduced with boll set even more severely effected. Bolls started to open about 2 weeks sooner than in 1979. An average of 18 lbs. of nitrogen per acre was applied at planting with an additional 57 lbs. per acre being applied on June 16 (Figure 33).

As shown in Figure 34 an average of 1.51 insecticide treatments (pyrethroids) were applied for the control of bollworm infestations. As in 1979 the APHIS operational group scouted all cotton (except for several fields in which the growers chose to provide their own scouts). Individual growers or spray group leaders determined the insecticide to be applied and time of application based on recommendations of the North Carolina Agricultural Extension Service. No weevil punctures were detected in intensively sampled fields during 1980. (On September 11, 1980, one boll weevil was trapped in a cotton field between Gaston, N. C. and the Virginia border. An extensive

examination of fruit yielded 1 pupa and 2 additional emerged boll weevils inside small bolls within the same field. Six additional adult weevils were trapped at the same site by September 24, 1980. No additional weevils have been captured in the subsequent 6-week period). Bollworms occured at low levels the first week of August, declining by mid-August to about 600 worms per acre (Figure 34). Both square and boll damage were similarly very light (Figure 35).

The average planting date was 2 days later than in 1979 but about 2 weeks earlier than in 1978. Excellent spring weather resulted in cotton getting a very strong start. However, plant growth was severely limited by the dry and hot weather encountered during July, August and early September. This was reflected in the size and number of bolls set. Average bollworm damage was not an important factor in this yield reduction (Figure 35).

Buffer Area: Weekly accumulations of rainfall in the Buffer Area are shown in Figure 36. Rainfall appeared adequate until mid-July. From then until early September an average of only .61 inches of rainfall occurred. Squaring began in mid-to-late June, peaked about July 15 and declined rapidly in late-July and early-August. Boll set started about July 15 and peaked two weeks later. The size and number of bolls set were affected by the inadequate rainfall.

As indicated (Figure 36), growers applied an average of 21 lbs. of nitrogen per acre at planting and an additional 54 lbs. per acre on June 20. This reflected an increased use of nitrogen over 1978 and 1979.

As shown in Figure 37, an average of 9 insecticide treatments were made in 1980. Four of these applications were made for the control of diapausing boll weevils. The other 5 treatments were for bollworm. In 1980, the APHIS operational group scouted all cotton fields twice weekly from early July

until early September (except for a few growers who chose to provide their own scouts). Individual growers or spray group leaders determined the insecticide to be applied and the time of application based upon recommendations of the North Carolina Extension Service.

Chlordimeform and pyrethroids accounted for 4.75 of the 5 bollworm applications. A single treatment of organophosphate was applied to 1 of the 4 intensively sampled fields in 1980. Insecticide treatments were applied for bollworm control from about July 20 to August 20. Estimated beneficial insect populations exceeded 30,000 per acre in mid-July before the onset of insecticide applications.

No boll weevil feeding or egg punctures were detected in the Buffer Area during 1980. Trap captures did indicate that migrating weevils were entering the area frequently with some resulting reproduction undoubtedly occurring.

The average planting date for intensively sampled fields in the Buffer Area was April 21. Bollworm and boll weevil damage did not appear to adversely affect yields. However, insufficient rainfall did adversely affect yields. An average of 484 pounds of lint was produced on the intensively sampled fields in 1980, compared with 759 pounds in 1979 and 980 pounds in 1978.

Chowan County: In 1980 as in 1979, Chowan County was used as a Methods Development Area by the APHIS operational group to test the effectiveness of microbial insecticides against the bollworm. All cotton in the County was included in this test and scouted by APHIS. Rainfall was spotty and light but generally adequate with an average of 4.79 inches of rainfall occurring between June 21 and September 1 (Figure 39). The overall weather conditions resulted in cotton maturing about 2 weeks earlier than in 1979.

An average of 22 lbs. of nitrogen was applied per acre at planting and an additional 77 lbs. on June 14. Soils in Chowan County are sandy and require more nitrogen than the clay soils in the Evaluation Area.

As indicated in Figure 40, no insecticide treatments were applied to intensively sampled fields in Chowan County. As in 1979, no boll weevils were detected in 1980. Beneficial insects generally remained at levels in excess of 10,000 per acre from June to September. A peak population in excess of 26,000 per acre occured in early August (Figure 40). As shown in Figure 41, bollworm damage to squares was very minimal with boll damage peaking at 7500 per acre the second week of August. The average yield of 603 lbs. per acre for the intensively sampled fields reflect the generally low bollworm damage levels and the favorable weather.

Scotland-Robeson Counties: Scotland-Robeson Counties represent 1 of 2 Current Insect Control practice areas located outside of the Boll Weevil Eradication Trial Area.

As shown on Figure 42, average rainfall appeared to be adequate with a total of 6.79 inches occurring between June 21 and September 1. Some fields received much less. This spotty rainfall, in combination with very hot temperatures resulted in an average yield reduction.

As indicated on Figure 42, 20 lbs. of nitrogen per acre was applied at planting with an additional 70 lbs. per acre applied on June 15. Boll set began in early July, peaked at approximately 240,000 per acre in early August and terminated in early September.

An average of 9.52 insecticide treatments per acre were applied by growers to control bollworm and boll weevil (Figure 43). While most of the treatments were initiated for bollworm control, at least 1 of the fields received a dual purpose (weevil and worm) first treatment. Average weevil

punctures exceeded 3000 per acre from early July to early August, far exceeding 1979 values. It appears clear that the boll weevil was not adequately controlled by the 1.5 treatments applied for their control nor the additional 8 treatments applied for bollworms (Figure 43). As shown in Figure 44, bollworm damage to squares and bolls was generally kept below damaging levels, although boll damage did reach an average of about 9000 per acre in mid-August. Boll weevil damage, spotty rainfall and very hot temperatures, along with bollworm damage, reduced yield. An average yield of 502 lbs. of lint was estimated for 1980.

Cleveland County: Cleveland County was 1 of 2 Current Insect Control practice areas located outside of the Boll Weevil Eradication Trial Area. Rainfall was excessive in June with 6 inches occurring about June 21 and deficient from then until August 10, with an average of 1.8 inches occurring during that 7-week period (Figure 46). As a result of the dry and hot conditions in July and early August, squaring was delayed and reduced. Boll set was similarly affected. An average of 26 lbs. of nitrogen was applied at planting with an additional 24 lbs. added on June 29 (Figure 45).

As shown in Figure 46, an average of 3.03 treatments of insecticide were applied. Two of the 4 intensively sampled fields received in-season azinphosmethyl treatments for boll weevil control. A third field was treated with a combination of pyrethroid, and toxaphene-methyl parathion for boll weevills and bollworms. By mid-July estimates of feeding and oviposition punctures indicated sizeable boll weevil populations were already in the fields.

Average beneficial populations remained at elevated levels from July to September despite the insecticide treatments. These averages were

maintained because 2 of the 4 sample fields were not treated with insecticide until an application for diapausing weevils was made in late September. The beneficial counts in the two fields receiving treatments declined as expected.

Bollworm damage to bolls and squares was negligible in the 2 fields not receiving inseason boll weevil treatments. Moderate bollworm damage did occur in the 2 fields receiving boll weevil treatments.

A poor yield of an average of 234 lbs. of lint per acre was the result of inadequate rainfall during July and early August. Yield losses were also attributable to boll weevil damage.

Use of insecticides in base-line fields sampled in 1977 and intensively sampled fields in 1978, 1979 and 1980.

Evaluation Area: The insecticide use pattern shifted between 1977 and 1980. This shift is shown in Table 5. In 1977, an average of 8.1 insecticide treatments were applied primarily for the control of bollworm. Dry weather in 1977 shortened the growing season by several weeks or several additional insecticide treatments would have been required to control the heavy bollworm populations that occurred. EPN-methyl parathion and toxaphene-methyl parathion were the predominant insecticides used with only limited use of methomyl and the pyrethroids (pyrethroids applied under experimental use permits). In 1978, Year I of the Boll Weevil Eradication Trial, approximately 5.6 insecticide treatments were applied for the control of diapausing boll weevils during September and October. The remaining 5.2 insecticide treatments were applied for bollworm control. An average of 1 treatment was pyrethroid insecticide, and 9.25 treatments were organophosphates applied in combination with methomyl or toxaphene. Chlordimeform was used as an ovicide against bollworm eggs in late July or early August. In contrast, during all

of 1979 and 1980, only 1.8 and 1.5 applications, respectively, of pyrethroid insecticides were applied per acre in the Evaluation Area.

Buffer Area: Insecticide use data were not collected in 1977. In 1978, an average of 0.64 treatments of pyrethroid insecticides were applied. Of the remaining insecticides applied, 12.36 applications were toxaphene-methyl parathion, methyl parathion-methomyl, or chlordimeform applied as an ovicide early in the season. In 1979, the pyrethroid applications increased to 5.25 and were used for bollworm control. There also was experimental use of Bacillus thuringiensis in 1979 for bollworm control. A total of 12.75 insecticide treatments were applied in the Buffer Area during 1979, with 3.75 of the organophosphate applications being for weevil diapause control. In 1980 bollworm pressure in the Buffer Area was less than in 1979, and is reflected by the total insecticide applications being reduced to 9. As in 1979, the majority of the organophophate applications were applied for weevil diapause control.

Chowan County: In 1977, Chowan served as a research and development area for the Eradication Trial. Eight applications of diflubenzuron were applied for suppression of boll weevil populations. Bollworm populations were controlled with either Bacillus thuringiensis, sulprofos, or toxaphene-methyl parathion. In 1978, Chowan County was used as a Methods Development Area by the APHIS operational group. Five applications of diflubenzuron (0.0625 lb. per acre application) were applied for the elimination of overwintered boll weevils followed by 1 application of azinphosmethyl (0.25 lb per acre) to kill emerged overwintered boll weevils. Subsequently, an average of 5.75 applications of toxaphene-methyl parathion or methyl parathion-methomyl were used for control of bollworms. In 1979 and 1980, the APHIS operational group used Chowan County to test microbial insecticides for bollworm control. In

1979 and 1980, the APHIS operational group used Chowan County to test microbial insecticides for bollworm control. In 1979, intensively sampled fields were the untreated check fields in this experiment. Therefore, no insecticides were applied. In 1980 beneficial populations provided adequate bollworm control in the intensively sampled fields and no insecticides, biological or otherwise were required.

Scotland-Robeson counties: Growers applied an average of 11.6 insecticide applications for bollworm control in 1977. One of these was a pyrethroid insecticide applied under an experimental use permit. The remaining applications were toxaphene-methyl parathion, EPN-methyl parathion, or methyl parathion-methomyl. In 1978, an average of 10.8 insecticide treatments were applied for bollworm control. Of these, 4.86 were pyrethroid insecticides, and the remainder were EPN-methyl parathion, toxaphene-methyl parathion, or methyl parathion-methomyl. In addition, chlordimeform was applied as an ovicide. In 1979, an average of 7.52 insecticide treatments were applied per acre for bollworm control. Of these, 4 were pyrethroid insecticides, and the remainder were toxaphene-methyl parathion, EPN-methyl parathion, and toxaphene-methyl and ethyl parathion. Chlordimeform was included with some treatments.

In 1980, pyrethroid applications increased by approximately 50% over 1979, from 4 to 6.5. This was reflected in the total number of insecticide applications increasing from 7.5 in 1979 to 9.5 in 1980. The number of insecticide applications for weevil control increased 6-fold from 1979 to 1980 (Table 5).

Cleveland County: Only 1 field of 8 received an application of methomyl for bollworm control in 1977. No insecticides were applied in 1978. In 1979 3 of the 4 intensively sampled fields received organophosphate treatments

for weevil diapause control. In 1980 an average of 1.6 early season insecticide applications were required for weevils (Figure 46). This was followed by an additional 1.4 applications for bollworm. This resulted in an average of 3.03 applications in 1980 contrasted to 0.75 in 1979 and 0 in 1978.

Use of insecticides in sampled fields in 1977, 1978, 1979 and 1980.

Insecticides applied in BWE Trial Area and two Current Insect Control practice areas in North Carolina are shown in Table 6.

Evaluation Area: The number of insecticide treatments applied in all sampled fields for bollworm control in 1978 were somewhat less than observed in intensive fields only, (Table 5). However, the total number of treatments in 1978 were similar for both groups of fields. In 1978 a total of 9.9 insecticide treatments were applied for both boll weevil and bollworm control. This was reduced to 2.5 in 1979 and to 1.2 in 1980.

Buffer Area: During 1978, an average of 13 insecticide treatments were applied in the intensively sampled fields (Table 5) while an average of 12 treatments were applied in all fields sampled (Table 6). In 1979, 12.8 treatments were applied in intensively sampled fields while an average of 12.9 treatments were applied in all fields sampled in the Buffer Area. In 1980 the applications dropped to approximately 9 in all sampled fields as well as the 4 intensive fields.

Chowan County: A Methods Development Area for the APHIS operational group. Bollworms received an average of 5.8 insecticide treatments in the intensively sampled fields during 1978 while an average of 4 treatments were applied for bollworm control in all fields sampled. As indicated earlier, the APHIS operational group used cotton fields in Chowan County to test the efficacy of microbial insecticides against the bollworm in 1979 and 1980. Intensively sampled fields in 1979 represented the untreated check

while all fields sampled represented the total treatments included in the large scale field experiment. Under these experimental conditions, 4.6 applications were applied for bollworm control. In 1980 only 1/3 of the fields required treatments for bollworm control. The 4 intensively sampled fields received zero treatments and all sampled fields received an average of .64 applications.

Scotland and Robeson counties: An average of 10.8 treatments were applied in intensively sampled fields in 1978 while an average of 9.4 treatments were applied to all fields sampled. In 1979, an average of 9.0 and 8.5 insecticide treatments were applied to intensively sampled and all fields sampled respectively. Insecticides applied during August of 1979 were for boll weevil suppression as well as for bollworm control. In 1980 an average of 9.5 treatments were applied in intensively sampled fields and 8.3 applications in all fields sampled. A 3-4 fold increase in treatments for boll weevil occurred in 1980 compared to 1979.

Cleveland County: Only one grower applied a single application of methomyl for bollworm control during September 1977. No insecticides were applied in 1978. During 1979, no insecticides were applied by growers for bollworms or for inseason control of boll weevils. However, ten fields out of twenty did receive boll weevil diapause treatments in combination with defoliant. In 1980, at least 4 of 21 fields received inseason control for boll weevil with 6 of the 21 fields receiving treatments for bollworm. Fourteen of 21 fields received boll weevil diapause control in conjunction with defoliation. Total insecticide treatments in 1980 increased 4-fold over 1979 (Table 5).

Table 5. Use of insecticides in base-line fields sampled in North Carolina, BWET, 1977 and intensively sampled fields in 1978, 1979 and 1980.

Year	No. of fields	Avg no of appl. for Boll weevil	Avg no of appl. for Boll-worm	% appl by aircraft	Average no. of lbs. of indicated insecticide/acre: Diflubenzuron	B. t.	Phosphate	Methomyl	Pyrethroid	Chlordimeform	Toxaphene
Evaluation Area											
1977	18	.4	7.7	94	0	0	8.5	.12	.03	0	10.8
1978	8	5.6	5.2	100	0	0	8.4	.09	.12	.06	1.3
1979	10	0	1.8	100	0	0	0	0	.22	0	0
1980	8	0	1.5	100	0	0	0	0	.15	0	0
Buffer Area											
1977	-	-	-	-	-	-	-	-	-	-	-
1978	4	.8	12.2	92	0	0	5.7	1.18	.14	.13	5.0
1979	4	5.3	7.5	100	.06	.56	1.3	0	.53	.44	0
1980	4	4.0	5.0	50	0	0	1.1	0	.42	.38	0
Chowan County											
1977	5	8.0	2.2	92	.35	.80	1.4	0	0	0	.4
1978	4	6.0	5.8	47	.31	0	5.7	.11	0	0	10.4
1979	4	0	0	0	0	0	0	0	0	0	0
1980	4	0	0	0	0	0	0	0	0	0	0
Scotland-Robeson Counties											
1977	5	0	11.6	88	0	0	10.4	.43	.10	0	7.4
1978	4	0	10.8	93	0	0	3.9	.55	.54	.13	2.3
1979	4	.25	7.3	93	0	0	2.5	0	.48	.39	2.1
1980	4	1.5	8.0	53	0	0	.61	0	.68	.13	.88
Cleveland County											
1977	8	0	.13	0	0	0	0	.03	0	0	0
1978	4	0	0	0	0	0	0	0	0	0	0
1979	4	.75	0	0	0	0	.19	0	0	0	0
1980	4	1.6	1.4	0	0	0	.78	0	.14	[illegible]	[illegible]

Table 6. Use of insecticides in fields sampled in North Carolina, BWET, 1977, 1978, 1979 and 1980.

Year	No. of fields	Avg. no of appl. for Boll weevil	Avg. no of appl. for Boll-worm	Average no. of lbs. of indicated insecticide/acre: Diflubenzuron	B. t.	Phosphate	Methomyl	Pyrethroid	Chlordimeform	Toxaphene	NPV
Evaluation Area											
1977	18	.4	7.7	0	0	8.5	.12	.03	0	10.8	0
1978	122	6.2	3.7	0	0	8.8	.12	.13	.02	2.9	0
1979	114	.4	2.1	.02	0	.1	.03	.20	.03	.1	0
1980	68	0	1.2	0	0	0	0	.12	.01	0	0
Buffer Area											
1977	-	-	-	-	-	-	-	-	-	-	-
1978	34	.7	11.3	0	0	10.4	.93	.11	.12	6.5	0
1979	18	5.1	7.8	.02	.56	1.9	0	.55	.50	0	0
1980	21	4.3	4.4	0	0	1.2	0	.37	.36	0	0
Chowan County											
1977	5	8.0	2.2	.35	.80	1.4	0	0	0	.4	0
1978	19	6.0	4.0	.24	0	4.5	.16	0	0	8.0	0
1979	27	0	4.6	0	.59	.1	0	.12	.29	0	.20
1980	25	0	.64	0	.21	.07[1/]	0	.004	0	.02[1/]	.005
Scotland-Robeson Counties											
1977	5	0	11.6	0	0	10.4	.43	.10	0	7.4	0
1978	16	0	9.4	0	0	3.6	.51	.48	.13	4.3	0
1979	21	.7	7.1	0	0	2.8	0	.50	.32	2.0	0
1980	20	2.0	6.3	0	0	1.9	.10	.55	.08	.48	0
Cleveland County											
1977	8	0	.1	0	0	0	.03	0	0	0	0
1978	20	0	0	0	.0	0	0	0	0	0	0
1979	20	.5	0	0	0	.16	0	0	.0	0	0
1980	21	1.2	.83	0	0	.73	.01	.07	.06	.45	0

[1/] Experimental or spider mite applications (not included in average bollworm applications).

Comparison of estimated yields in intensively sampled fields with all fields sampled during 1977, 1978, 1979 and 1980.

Estimated yields for fields sampled in 1977-1980 are presented in Table 7. As shown, estimated yields in intensively sampled fields were generally similar to yields in all fields sampled with the exception of the Buffer Area in 1980. Although the cotton growing area of the Buffer is relatively small, rainfall varied significantly between fields. This is reflected in the wide variability of yields within the area. The excellent yields recorded in 1978 reflect the highly favorable weather which occurred during most of the growing season. The generally average and below yeilds in 1980 were the result of a very dry growing season.

Table 7. Estimated yield (lbs. lint/acre) of fields sampled for Biological Evaluation of the Boll Weevil Eradication Trial. North Carolina. 1977, 1978, 1979 and 1980.

	Intensive fields		Total fields	
year	No. of fields	Avg. lbs. lint/acre	No. of fields	Avg. lbs. lint/acre
		Evaluation Area		
1977		1/	18	567
1978	7	740	124	691
1979	10	511	114	499
1980	8	382	68	415
		Buffer Area		
1977		2/	2/	2/
1978	4	980	35	923
1979	4	759	18	727
1980	4	484	20	624
		Chowan County		
1977		1/	5	473
1978	4	723	18	740
1979	3	481	24	549
1980	4	603	25	510
		Scotland-Robeson Counties		
1977		1/	5	229
1978	4	734	19	664
1979	3	532	16	478
1980	4	502	20	483
		Cleveland County		
1977		1/	8	293
1978	4	464	20	516
1979	3	276	18	320
1980	4	274	21	319

1/ No intensive fields in 1977.

2/ Fields were not sampled in the Buffer Area in 1977.

Border Vegetation

Aerial photographs were taken of all Biological Evaluation fields. Ground surveys were made to determine the composition of surrounding vegetation. The results of the 1978, 1979 and 1980 surveys are presented in Table 8. This information except for Chowan 1979 is from intensive fields. The 1979 information for Chowan was from 4 randomly selected fields other than intensive fields. The 1979 intensive fields in Chowan were small (1-3 acres) check fields utilized by APHIS in a Methods Development test. The surrounding vegetation for these small fields was not representative of other Chowan County cotton fields. The border vegetation of cotton fields varies markedly among the 5 sample areas.

Evaluation Area: The Evaluation Area is located on the northeastern edge of the Piedmont and in the upper Coastal Plain (Figure 1). Border vegetation of sample cotton fields in this area are the most divergent of the 5 areas. The important difference between this area and the other areas, except Chowan, is the presence of peanuts. Peanuts comprise an average of 20% of the border vegetation for cotton fields. Peanuts are involved in the cotton rotation program in this area and are not generally grown commercially in the Buffer Area, Scotland-Robeson or Cleveland counties. Peanuts and soybeans are attractive hosts for bollworm during August in the Evaluation Area and probably dilute the bollworm attack on cotton. About 55% of the border vegetation in the Evaluation Area is normally treated at least once per year with insecticide.

Buffer Area: The Buffer Area is located in the central Coastal Plain (Figure 1). Tillable farm land is intensively utilized as is reflected by the low incidence of abandoned fields being found in the border vegetation. Abandoned fields average 3-17% in the other 4 areas. Approximately 43% of

the border vegetation is treated with insecticide at least once per year in the Buffer Area.

Chowan County: Chowan County is located in the northeastern Coastal Plain (Figure 1). Peanuts make up an average of 14% of the border vegetation of the sampled cotton fields with other cotton fields accounting for only 9%. This low percentage for cotton is explained by Chowan County having only approximately 400, 700 and 1600 acres of cotton in 1978, 1979 and 1980 respectively. Truck farming is an important factor in the agriculture of this area and is reflected by 12% of the border vegetation being categorized as miscellaneous. This miscellaneous catagory consisted of truck crops made up largely of melons, bell peppers, squash, snap beans and sweet corn. Peanuts and soybeans, significant hosts for bollworm, make up about 30% of the border vegetation for cotton. An average of 47% of the border vegetation for sampled cotton fields in Chowan County consists of crops that are normally treated with insecticide at least once per year.

Scotland-Robeson counties: Scotland-Robeson counties are located in the southern Coastal Plain (Figure 1). This is one of the most intensive cotton producing areas of North Carolina. In 1979 the two counties contained a total of approximately 15,000 acres of cotton. This large acreage is reflected by 48% of the border vegetation being additional cotton fields. Tobacco accounts for 4% of the border vegetation in the sampled cotton fields for these two counties. This is much higher than the other 4 areas and may explain why *Heliothis virescens* occurs more frequently here in cotton than in the other 4 areas. Approximately 64% of the border vegetation in Scotland-Robeson counties consists of crops that are normally treated with insecticide at least once per year.

Cleveland County: Cleveland County is in the upper Piedmont and foothills

of southwestern North Carolina (Figure 1). Corn acreage is very low in the county (Figure 2) and comprises only 1% of the border vegetation for the sampled cotton fields. Pasture and abandoned fields account for almost 21% of the border vegetation. These abandoned fields probably provide an important overwintering site for beneficial insects and weevils. The combinations of low corn acreage and plentiful overwintering sites for beneficial insects and weevils play an important part in the abundance of beneficials, the general absence of economic damage by bollworms, and the relatively high boll weevil populations (Figures 15 & 31).

Table 8. Border vegetation survey for intensively sampled fields in 1978, 1979 and 1980.

	% of field border/category												
							Abandoned	Woods			Resi-		Insecticide
Year	Corn	Soybeans	Peanuts	Cotton	Tobacco	Pasture	field	Pine	Decid.	Mixed	dential	Misc.	treated
						Evaluation Area							
1978	16.87	16.25	16.12	19.62	0.00	3.38	6.38	0.00	10.38	3.00	5.88	2.12	51.99
1979	17.10	5.80	26.80	15.40	1.90	3.80	4.40	4.50	.90	7.30	7.00	5.10	49.90
1980	13.13	6.00	16.13	42.25	0.00	7.63	0.00	0.00	1.75	.86	12.25	0.00	64.38
Avg.	15.70	9.35	19.68	25.75	.63	4.94	3.59	1.50	4.34	3.72	8.38	2.41	55.42
						Buffer Area							
1978	2.75	29.50	0.00	13.50	3.00	2.75	0.00	5.50	9.25	11.75	17.00	5.00	46.00
1979	30.25	0.00	0.00	30.75	1.75	0.00	0.00	5.50	0.00	20.25	1.50	10.00	32.50
1980	6.00	16.75	0.00	34.75	0.00	3.75	2.25	0.00	2.25	7.00	15.00	12.25	51.5
Avg.	13.00	15.42	0.00	26.33	1.58	2.17	.75	3.67	3.83	13.00	11.17	9.08	43.33
						Chowan County							
1978	9.00	15.25	17.00	2.25	0.00	0.00	4.25	0.00	0.00	25.00	0.00	27.25	61.75
1979	28.25	12.50	13.25	14.50	0.00	0.00	2.75	0.00	0.00	15.00	7.50	6.25	40.25
1980	13.25	16.50	12.75	10.75	0.00	0.00	0.00	0.00	12.50	4.00	28.25	2.0	40.00
Avg.	16.83	14.75	14.33	9.17	0.00	0.00	2.33	0.00	4.17	14.67	11.92	11.83	47.33
						Scotland-Robeson Counties							
1978	7.75	0.00	0.00	56.26	0.00	3.00	0.00	16.75	11.00	0.00	5.25	0.00	56.25
1979	11.25	16.50	0.00	37.25	12.75	5.25	10.50	.75	.50	1.00	2.25	2.00	66.50
1980	6.82	17.98	0.00	51.04	0.00	0.00	10.35	0.00	3.45	0.00	4.64	5.75	69.02
Avg.	8.61	11.49	0.00	48.18	4.25	2.75	6.95	5.83	4.98	0.33	4.05	2.58	63.92
						Cleveland County							
1978	0.00	12.25	0.00	25.25	0.00	4.50	16.75	1.75	3.50	10.25	16.75	9.00	0.00
1979	4.00	4.25	0.00	15.50	0.00	18.00	18.50	7.50	12.75	0.00	14.00	5.50	0.00
1980	0.00	1.27	0.00	34.83	0.00	0.00	4.29	4.66	2.66	14.77	31.68	5.84	23.22
Avg.	1.33	5.92	0.00	25.19	0.00	7.50	13.18	4.64	6.30	8.34	20.81	6.78	7.74

Comparisons of insect populations and damage for 1977 fields and 1978, 1979, and 1980 intensive fields

The estimated bollworm populations and boll weevil and bollworm damage for each of the 5 areas is presented in Figures 48-86. Sample fields were not located in the Buffer Area during 1977, therefore, no data are presented for the Buffer Area in 1977.

Boll Weevil: The estimated number of boll weevil punctures (feeding and egg) for the 5 sampled areas are presented in Plots 48-52.

The Evaluation Area (Figure 48) experienced an average of approximately 500 weevil punctures per acre in 1977. In 1978 a few weevil punctures were detected in mid-July and mid-to-late August. In 1979, a few feeding punctures were again detected in July and early August. However, these punctures were attributed to the sterile weevils released from June 18 through July 9, as part of the Eradication Program, since no reproduction was detected. No punctures were detected in 1980.

On September 11, 1980 one boll weevil was trapped in a cotton field between Gaston, North Carolina and the Virginia border, just west of Interstate Highway 95. An extensive examination of fruit yielded 1 pupa and 2 additional emerged weevils inside small bolls within the same field. Trap density was increased from 2 to 10 per acre. Six additional adult weevils were trapped at the same site by September 24. No additional weevils have been captured.

The cotton was in an advanced state of maturity by September 11. It was subsequently harvested and the stalks shredded within a few days. The most likely source of this small infestation appears to have been a hitchhiking female weevil coming up Highway I-95 by automotive traffic. Other possibilities, though remote, are that a native fertile female weevil emerged

from an extended diapause (2 years) or that a migrating female flew some 100 miles north from known infested cotton. Research data relating to boll weevil reproduction and detection does not support the real possibility of a low level, endemic breeding population of boll weevils being responsible for the infestation.

The Buffer Area (Figure 49) exhibited more weevil punctures in 1978 and 1979 than the Evaluation Area. In 1978 average damage of approximately 1200 punctures per acre occurred in mid-August. In 1979, average damage of approximately 500 punctured squares per acre occurred in early July. As in the Evaluation Area, these punctures were attributed to the sterile weevils released in the eradication effort. However, low levels of weevil reproduction may have resulted from weevils migrating up from Scotland and Robeson counties. No weevil punctures were observed in the intensively sampled fields in 1980.

In Chowan County the last recorded boll weevil puncture occurred in July of 1977 (Figure 50). The last boll weevil capture occurred about 1 year later on June 28, 1978. Boll Weevil Trial technology was applied in Chowan County a year earlier than in the Eradication Area. This resulted in the boll weevil being eradicated from Chowan County in 1978. Consequently no weevil punctures were detected during 1978, 1979 or 1980.

Scotland-Robeson counties experienced relatively low but season-long boll weevil damage during 1977 (Figure 51). The three peaks in early July, early mid-August, and mid-September occurred where the successive generations would be anticipated. Organophosphate insecticides used during 1977 to control the significant bollworm population also provided significant weevil control. This accounts for the August and September generations remaining low. The ensuing severe winter and extremely late spring in 1978 reduced

the overwintering weevil population resulting in few weevil punctures being detected in 1978. A shift away from organophosphate insecticides in 1978 (Table 6) probably aided the weevil population buildup in 1979. During 1979 several fields experienced damage with punctures for intensively sampled fields, reaching an average of approximately 2000 per acre. The weevil population buildup continued into 1980 with punctures reaching an average of 7500 per acre for the intensively sampled fields. Some fields in 1979 and 1980 appeared to experience economically important yield reductions due to boll weevil damage.

Cleveland County experienced damaging boll weevil populations in several sampled fields in 1977 (Figure 52). The severe winter of 1977-1978 likely reduced the emerging population in the spring of 1978. As a result of low winter survival weevil punctures were not detected in the intensively sampled fields in Cleveland County until the 2nd generation appeared about the week of July 21 with a peak average punctures per acre of approximately 800. No insecticides were applied for bollworm or weevil control in 1978. The severe winter of 1978-1979 again reduced the overwintering population significantly. The first punctured squares in 1979 were detected in early August. During August most of the sampled fields developed low to moderate populations of weevils. Diapause treatments were recommended to the growers with about 50% responding with treatments. The relatively mild winter of 1979-1980 allowed large numbers of weevils to overwinter. This resulted in two of the four intensively sampled fields receiving a total of 5.6 inseason treatments for boll weevil control plus an additional 5.5 treatments for bollworm control. This combined with two additional diapause treatments resulted in a sizeable increase in the number of insecticide treatments (Table 5) (1.6 weevil and 1.4 bollworm) applied to the intensively sampled

fields in 1980 over 1979.

Bollworm larvae in terminals: The estimated number of bollworm larvae in terminals for the 5 sampled areas for 1977-80 is shown in Figures 53-57.

The Evaluation Area values (Figure 53) normally peak in late August and early September. However, important levels of bollworm larvae did not occur in the terminals in either 1977, 1978, 1979, or 1980 in the intensively sampled fields.

The Buffer Area (Figure 54) experienced a peak of about 1800 per acre in mid-July of 1978. This was partially the result of several excessively vegetative cotton fields included in the intensively sampled fields. In 1979 and 1980 little bollworm activity was detected in the terminals.

Chowan County (Figure 55) experienced few bollworms in the terminals during 1977, 1979 or 1980. In 1978, 200-300 larvae per acre did occur in terminals the 2nd week of July through the 3rd week of August. No importance is attributed to these differences.

Scotland-Robeson counties (Figure 56) experienced higher populations of bollworms in terminals than the other 4 areas for all 4 years. In 1977, a peak of approximately 1100 bollworms per acre occurred in terminals the week of August 8. Other peaks occurred in mid-July and early September. In 1978, two peaks occurred in late July and August. In 1979, peaks corresponding to those observed in 1978 occurred 1-2 weeks earlier. In 1980 a few bollworm larvae (about 200 per acre) occurred in terminals in mid-August.

Cleveland County recorded no bollworm larvae in terminals during 1978 or 1979. In 1977, a noticeable peak did occur in early September. The unusually hot, dry summer of 1977 resulted in atypical fruiting conditions and corresponding insect damage. September rains resulted in vigorous vegetative growth late in the season which was highly attractive for egg

laying by bollworm moths. In 1980 two minor peaks did occur, the first in late July and the second in late August.

Bollworm larvae in squares: The estimated number of bollworm larvae in squares for the 5 sampled areas for 1977-80 is found in Figures 58-62.

The Evaluation Area (Figure 58) experienced a peak 2-3 weeks earlier in 1977 than in the other 3 years. In 1978, 1979 and 1980 some bollworm larvae were detected in squares during July with peaks for the 3 years occurring in mid-August.

The Buffer Area (Figure 59) experienced high levels of bollworm larvae in squares from July through late August of 1978. A peak of approximately 10,000 larvae per acre occurred the first week of August. Again, just as occurred with the terminals, these high populations were attracted to several very lush green fields included in the intensively sampled fields. In 1979, the level of bollworms in squares was lower than in 1978 with average peaks for the 4 intensively sampled fields of approximately 2000 per acre and 800 per acre occurring the second week of July and the first week of August, respectively. In 1980 damaging levels of bollworms did not occur in squares among the 4 intensively sampled fields.

Chowan County (Figure 60) experienced an early peak of about 850 per acre in mid-July of 1977 with minor peaks also detected in early August and late September. In 1978, moderate levels of bollworms occurred in squares throughout the season with a peak of about 1800 per acre occurring in late August. In 1979, populations of approximately 1400 per acre occurred the last 2 weeks of August. In 1980 only a few larvae were found in squares in intensively sampled fields.

Scotland-Robeson counties (Figure 61) experienced the highest levels of bollworms in squares of any of the 5 areas in 1977. Levels in 1978

were similar to those in the Buffer Area. Few larvae were found in squares during 1979 with only one record of 750 per acre occurring in mid-August.

Cleveland County (Figure 62) experienced moderate numbers of bollworms in squares during both 1977 and 1978. The peaks that occurred in mid-September of 1977 and in late August of 1978 appear high for an area that infrequently experiences an economic bollworm problem. However, these two larval peaks occurred in the absence of insecticides and at a time when squares would not generally yield harvestable bolls.

Bollworm damaged sqaures: The estimated number of bollworm damaged squares in the 5 sampled areas for 1977-1980 is found in Figures 63-67. The Evaluation Area (Figure 63) experienced peak square damage the week of July 15 in 1977 (3500 per acre). In 1978, 1979 and 1980, peaks occurred during the first two weeks of August. The 1978 peak was approximately 2500 damaged sqaures per acre. In 1979 and 1980, the peak was nearly 1300 damaged squares per acre.

The Buffer Area (Figure 64) experienced two important periods of bollworm damaged squares in 1978. The first occurred in early to mid-July (ca. 12,000 per acre). The second peak occurred in early August (ca. 13,000 per acre). In 1979, square damage was not as severe as in 1978. This was generally true statewide. The 1979 peaks occurred in the same general time span as the 1978 peaks. The July peak in 1979 was only approximately 3500 per acre with the August peak being about 1500 damaged sqaures per acre. In 1980 square damage was at lower levels than 1979 with average damage not exceeding 1500 per acre.

Chowan County (Figure 65) experienced early square damage (July 15) in 1977. In 1978, early and late August peaks occurred. The peak occurring in late August reached approximately 3000 per acre. The levels of square

damage observed in 1979 were higher than the previous two years but do not necessarily reflect greater bollworm pressure. The 1979 intensive fields served as check fields for an APHIS Methods Development program and received no insecticide treatments for bollworm control. In 1980 square damage was lower than the previous 3 years. The number of insecticide applications was also lower than the previous 3 years (Tables 5 and 6).

Scotland-Robeson counties (Figure 66) experienced higher levels of square damage than the other 4 areas. This is the southernmost area of the 5 sampled. Bollworm damage generally occurs here earlier than in other parts of North Carolina. In 1977, bollworm square damage peaked in early July (ca. 14,000 per acre) and again in late August (ca. 12,000 per acre). The unusually hot and dry summer followed by fall rains resulted in the cotton plants becoming attractive to adult moths late in the growing season. In 1978, average square damage was significant between late July and late August. Peak square damage levels of approximately 56,000 per acre occurred in early August. In 1979, bollworm square damage appeared earlier than in 1978 with the first peak occurring in the first two weeks of July (17,000 per acre). The second peak appeared in early August (ca. 27,000 per acre). In 1980 average square damage was much less than the 3 previous years. Cotton matured earlier in 1980 than the previous 3 years. This early maturity combined with lower bollworm populations were largely responsible for the reductions in square damage.

Cleveland County (Figure 67) experienced 3 peak periods of square damage in 1977. The first occurred in early July (3000 per acre), the second in early August (6000 per acre) and the third in mid-September (ca. 13,500 per acre). In 1978, the July and August peaks paralleled the 1977 peaks. The 3rd peak occurred about 3 weeks earlier than in 1977. Those levels of

square damage occurred in the absence of insecticide treatments. Bollworm square damage was at very low levels in both 1979 and 1980.

Bollworms and Bollworm damaged bolls: The estimated number of bollworms and bollworm damaged bolls per acre in the 5 sampled areas for 1977-1980 is presented in Figures 68-82. In general, the seasonal trends in bollworms and bollworm damaged bolls were closely correlated in 1978, 1979 and 1980. The most pronounced example of this correlation is Chowan County, (Figures 76, 77 and 78). However, in 1977, the correlation between these two estimates was not apparent. The hot, dry summer followed by the wet fall resulted in unusual plant growth conditions. Some fields set few bolls until September. This factor was most evident in the Evaluation Area and in Scotland-Robeson counties (Figures 68 and 79). Levels of bollworm damaged bolls for 1977 ranged from approximately 10,000 in Cleveland County (Figure 83) to in excess of 25,000 in Scotland-Robeson counties (Figure 79). Damage levels in 1978, 1979 and 1980 were more moderate. Chowan County experienced high levels of bollworms and bollworm damaged bolls in both 1978 and 1979 (Figures 76 and 77). The 1979 estimates for Chowan County were made in insecticide-free check plots utilized by APHIS in a Methods Development Program. Cleveland County experienced the lowest bollworm populations and bollworm damaged bolls of the 5 areas in both 1978 and 1979 (Figures 84 and 85). However, in 1980 due in part to the need for several inseason treatments for boll weevil, beneficial insect populations were reduced allowing bollworm populations to reach damaging levels in some fields. Insecticides were not utilized for bollworm control in 1978 or 1979 in Cleveland County. In 1980 an average of 1.4 treatments were applied for bollworm control.

Beneficial Arthropod populations in 1977 sampled fields and in 1978, 1979 and 1980 intensively sampled fields

Estimated beneficial arthropod populations based on D-Vac samples taken in the 5 sample areas of North Carolina for 1977-1980 are presented in Figures 87-131. Each area is represented by 9 separate figures. The first figure for each area depicts the total number of beneficial insects and spiders except for predacious thrips. The second figure presents only those beneficials considered important for controlling bollworm. The individual species or groups of species comprising the second figure are presented separately in the remaining 7 figures.

Evaluation Area: The beneficial populations are presented in Figures 87-95. The populations increased each year from 1978-1980 (Figure 87). The important beneficials have increased also during the same period with major increases occurring in 1980 (Figure 88). Geocoris sp. (Figure 89), Orius insidiosus (Figure 90), Chrysopa sp. (Figure 93) and Lynx spiders (Figure 95) appeared to have comprised much of the increase.

Buffer Area: The beneficial populations are presented in Figures 96-104. The populations of both beneficials and important beneficials have increased steadily since 1978 (Figures 96 and 97). Orius insidiosus a major component of that increase, exceeded 6000 per acre during the last three weeks of July in 1980 (Figure 99). This was the same period cotton typically received the first damaging populations of bollworms. Orius no doubt played an important role in reducing bollworm damage by reducing the number of bollworm eggs. Chrysopa (Figure 102), though only a minor beneficial in number during 1978 and 1979, built up to levels exceeding 2000 per acre in mid-July of 1980.

Chowan County: The beneficial populations are presented in Figures

105-113. Beneficials and important beneficials reached high levels in all 4 years (Figures 105 and 106). In 1977 the populations peaked before damaging bollworm infestations developed. Beneficial populations were probably reduced the remainder of the season by numerous insecticide applications for bollworm and boll weevil. Again in 1978 beneficial levels were probably limited by insecticide applications. Both in 1979 and 1980 insecticide treatments were not applied to intensively sampled fields. In both years beneficials exceeded 20,000 per acre during the first two weeks of August (Figures 105 and 106). Early August is when bollworms normally reach economic levels in Chowan County. All but 2 groups, Nabids (Figure 112) and Lynx spiders (Figure 113) of the 7 species or group of species making up the important beneficials reached significant population levels. Of these 5, Orius insidiosus (Figure 108) and Chrysopa sp (Figure 111) were the most numerous. Both are important predators in the control of bollworm.

Scotland-Robeson Counties: The estimates of beneficial populations are presented in Figures 114-122. Beneficial populations here occurred 1-2 weeks earlier than in the other 4 areas. This is a reflection of the warmer climate. Beneficial populations generally reached relatively high levels before declining rapidly as insecticide applications for bollworm were initiated about mid-July (Figures 13, 28 and 43). In both 1978 and 1979 Orius insidiosus was present in large numbers (Figure 117). In 1980 both Chrysopa sp. and Nabids populations reached levels several times higher than in the previous three years (Figures 120 and 121).

Cleveland County: The estimates of beneficial populations are presented in Figures 123-131. Beneficial populations throughout the 4 years of D-Vac sampling have been higher here than for the other sampled areas in North Carolina. Beneficial populations exceeded 20,000 per acre for substantial

periods of time in 1978, 1979 and 1980 (Figure 123). Population levels for important beneficials (Figure 124) were at significantly reduced levels in 1979 compared to 1978 and 1980. However, beneficials overall were generally at levels exceeding the previous 3 years (Figure 123). This reduction was experienced for each of the 7 species or groups of species comprising the important beneficial estimates (Figures 125-131). A cool spring, with some cotton receiving frost damage in late May, could have been responsible for part of the decline in beneficial levels but does not totally explain the season long reduction. No inseason insecticide treatments were applied in 1978 or 1979. In 1980 beneficial levels returned to or exceeded the 1978 levels (Figures 123-124). As in Scotland-Robeson counties Chrysopa sp. reached levels in 1980 several fold greater than experienced in the previous 3 years.

Estimates of both total and important beneficial arthropod populations have increased during the period 1978-1980 in the 3 sample areas included in the Eradication Trial. The two Current Insect Practice Areas outside the Trial have also demonstrated some increases in beneficial populations during the same period. The increases for the Evaluation Area and Chowan County were the most dramatic. These two Areas also experienced the greatest reduction in insecticide applications during the same period (Tables 5 and 6). Beneficial population levels in the Buffer Area and Scotland-Robeson Counties though increasing have remained at relatively low levels, perhaps reflecting the significant number of insecticide applications. Benefical populations in Cleveland County reached higher levels and maintained these levels for a longer portion of the growing season than either of the other 4 areas sampled. Correspondingly, the inseason application of insecticides was zero in 1978 and 1979 (.75 in 1979 for diapause control of boll weevil). In

1980, 2 of the 4 intensively sampled fields required in-season control for boll weevil as well as subsequent treatments for bollworm (Table 5). The two fields receiving insecticide treatments experienced sharp reductions in beneficial insect levels. The average beneficial population for the 4 intensively sampled fields was maintained at high levels by the large counts experienced in the 2 untreated fields.

Trap-line captures of boll weevils in 1978, 1979 and 1980.

Two trap-lines (Figure 1) were established in April, 1978. Both lines radiated southwestward from Scotland Neck in Halifax County (Evaluation Area). The easternmost line runs through the cotton growing region in the Buffer Area, terminating in Robeson County. The westernmost line runs through the non-cotton producing region of the Buffer Area terminating in the cotton growing region of Montgomery County. Each trap location consists of 3 Leggett traps. The three traps are 50 feet apart in a line. The trap locations are 5 miles apart located on highway right-of-ways. The traps are not cotton field oriented. Traps are serviced weekly from April through November, and monthly December through March.

Weevil captures for the two trap lines are summarized in Figures 132 and 133. In Figure 132, traps located 30 miles or less from the northern end of the trap-line are in the Evaluation Area. Those located between 30 and 110 miles from the north end of the trap line are in the Buffer Area. Traps located greater than 110 miles from the northern end are outside the Eradication Trial Area.

In 1978, 1 weevil was captured at the northernmost trap location in early July. This probably does not reflect migration because native weevils still infested the area (Figure 1). This was the only weevil captured in the trap line traps in the Evaluation Area during 1978, 1979 and 1980. In the

Buffer Area during 1978, 1979 and 1980; 22, 105 and 357 weevils were captured each year, respectively. Not only were more weevils captured each of the 3 succeeding years in the Buffer Area, they were also captured closer to the Evaluation Area each year. In 1978 the northernmost capture was 60 miles south of the Evaluation Area; in 1979--50 miles south, in 1980--35 miles south.

The location and number of weevils captured in the Buffer Area appear to be a function of the population density outside the Eradication Area (110+ miles south on the trap line) and the subsequent migration of these weevils northward. As indicated in Figure 132, weevil captures increased dramatically during the 3 years of trap-line operation. In 1978, 1979 and 1980; 170, 728 and 2919 weevils, respectively, were captured outside the Eradication Area.

The seasonal captures of boll weevils is shown in Figure 133. A few weevils were captured in the spring as weevils emerged from diapause. The major captures were during fall migration in August and September. In 1979, a peak capture occurred in late June and early July. These captures were marked, sterile weevils released as part of the Eradication program.

APHIS installed a 1000 mile network of trap-lines throughout the Buffer Area in the fall of 1979. This was replaced by an extensive grid-trapping system in the spring of 1980. This grid consisted of traps located 3 miles apart covering all of North Carolina east of Greensboro, excluding the Evaluation Area and eastward to the coast. The weevil captures on the grid, though much more extensive, reflected the findings of the trap-lines presented in Figures 132 and 133.

ADDENDUM

Figure 1. Location of sampling areas and trap lines for Biological Evaluation of the Boll Weevil Eradication Trial in North Carolina, 1978, 1979, and 1980.

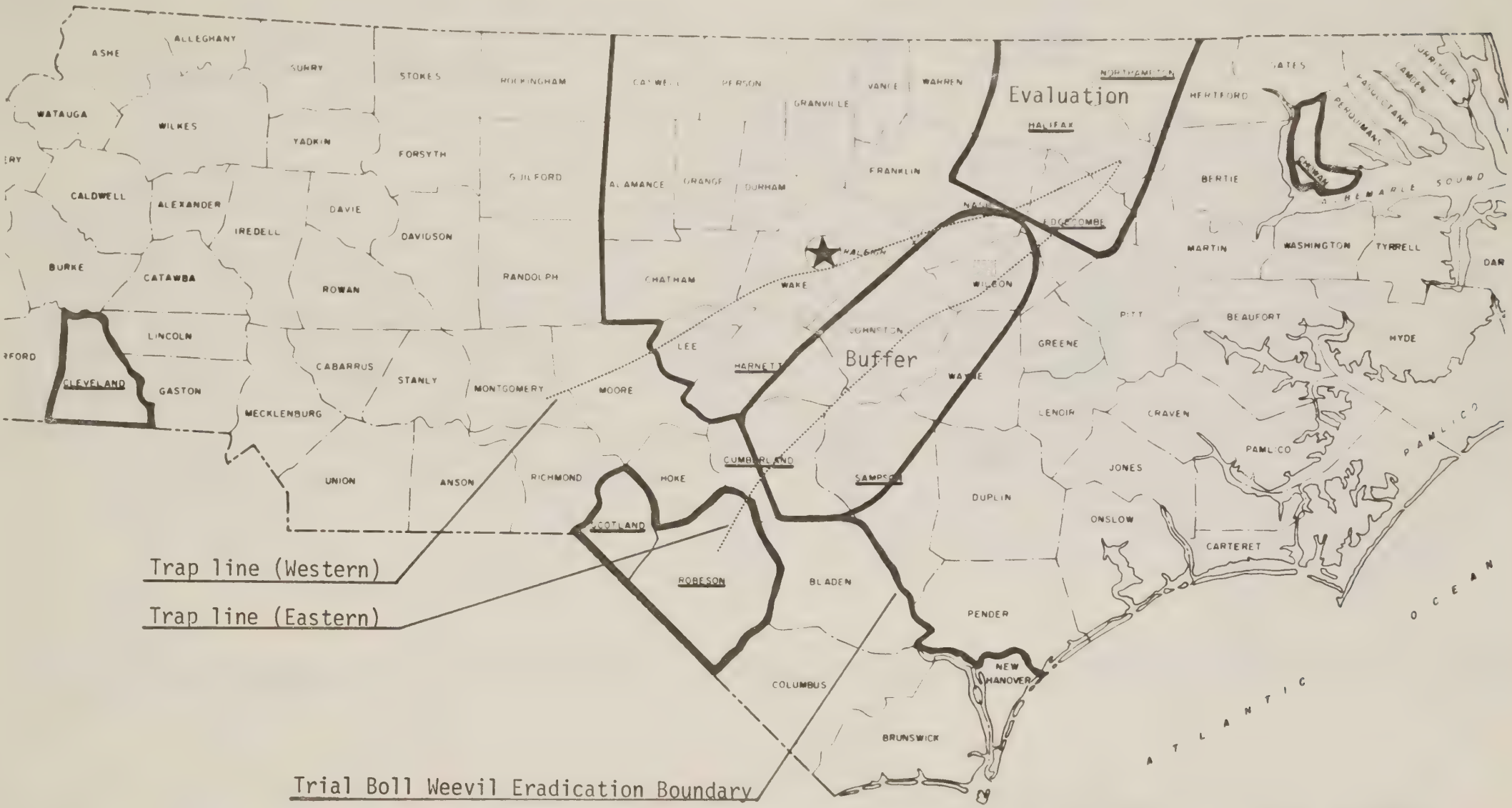


Figure 2. Corn acreage harvested for grain in North Carolina in 1978. (Each dot = 2,000 acres.)

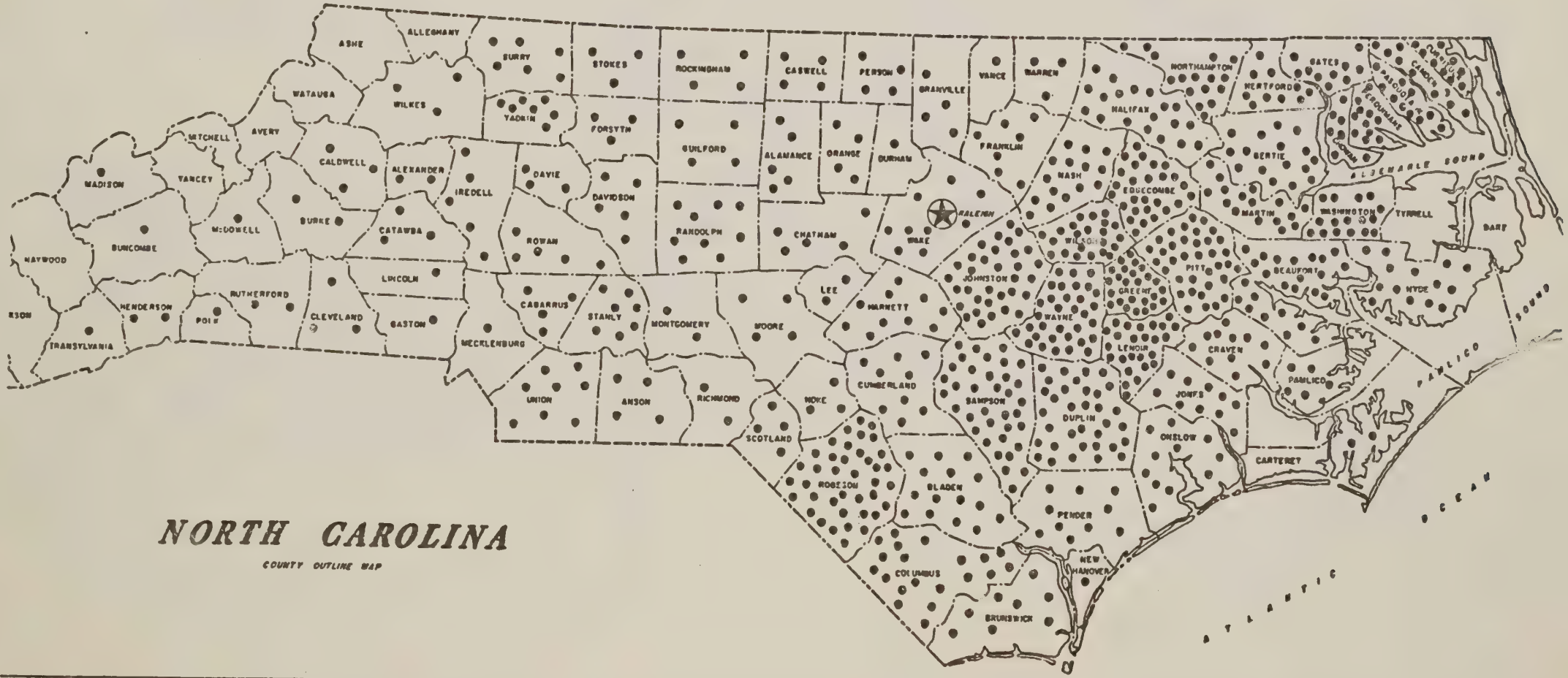
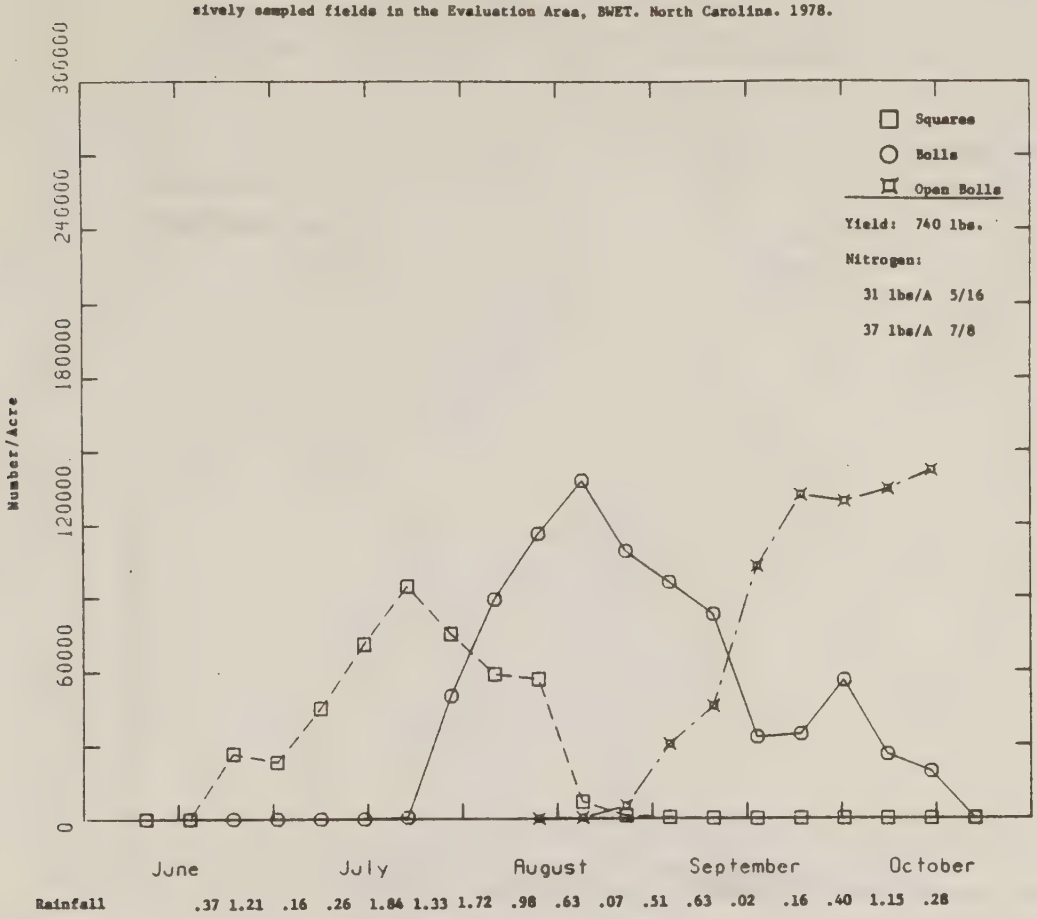
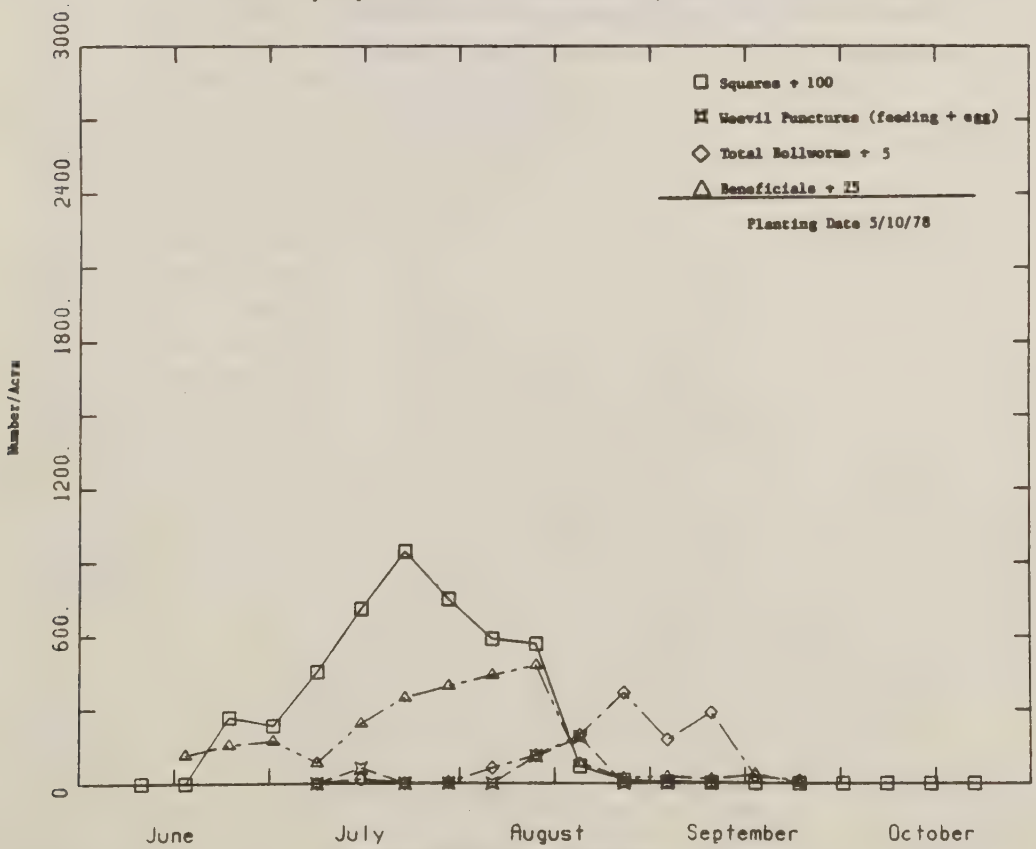


Figure 3. Estimates of squaring, boll set, boll opening, rainfall, use of nitrogen, and yield in intensively sampled fields in the Evaluation Area, BWET. North Carolina. 1978.



Rainfall .37 1.21 .16 .26 1.84 1.33 1.72 .98 .63 .07 .51 .63 .02 .16 .40 1.15 .28

Figure 4. Estimated no. of squares, boll weevil punctures (feeding and oviposition), total bollworms, beneficial arthropods (except predacious thrips) per acre, and no. of insecticide treatments in intensively sampled fields in the Evaluation Area, BWET. North Carolina. 1978.



Insecticide Applications/Field/Week

																Total
Pyrethroid						0.69	0.31									1.00
Chlordimeform			0.25	0.25												0.50
Organophosphate (± toxaphene)						0.13	1.00	0.82	1.37	1.13	0.75	1.12	0.75	1.00	1.00	9.07
Methomyl						0.06	0.06	0.06								0.18
																10.75

Figure 5. Estimated no. of bollworm damaged bolls and squares per acre in intensively sampled fields in Evaluation Area, BWET. North Carolina. 1978.

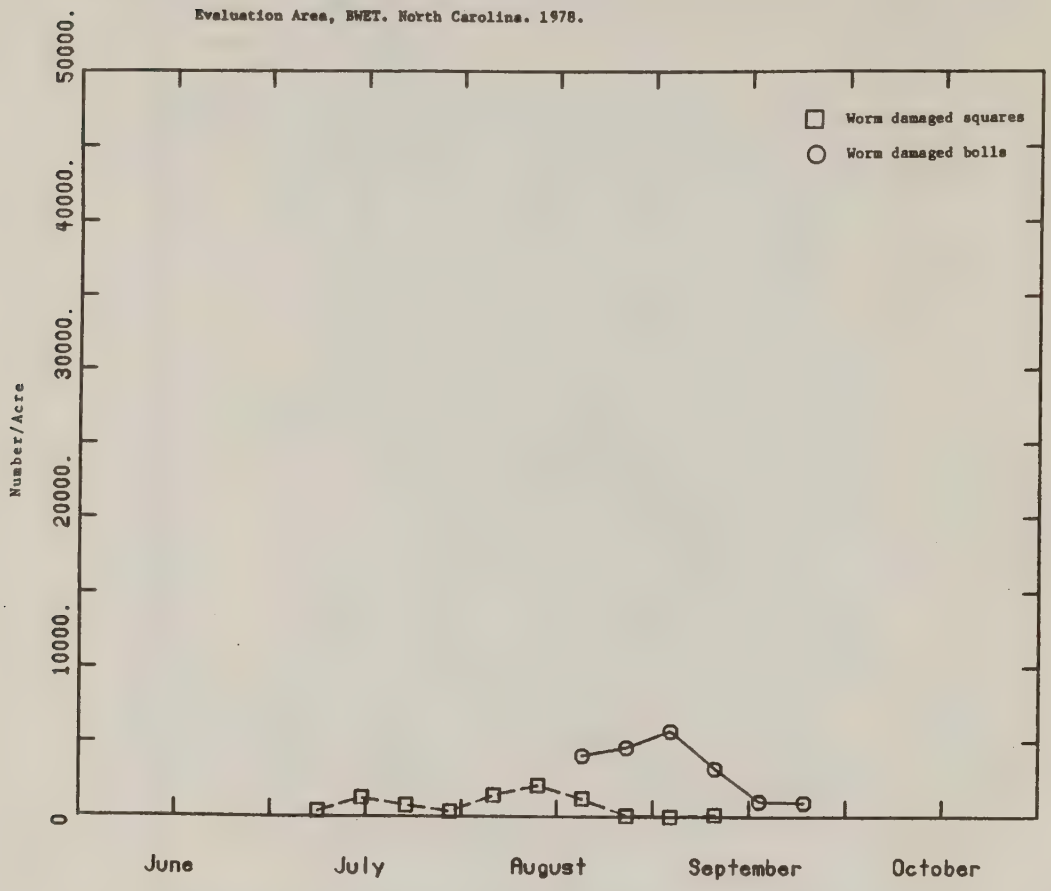


Figure 6. Estimates of squaring, boll set, boll opening, rainfall, use of nitrogen, and yield in the intensively sampled fields in the Buffer Area, BWET. North Carolina. 1978.

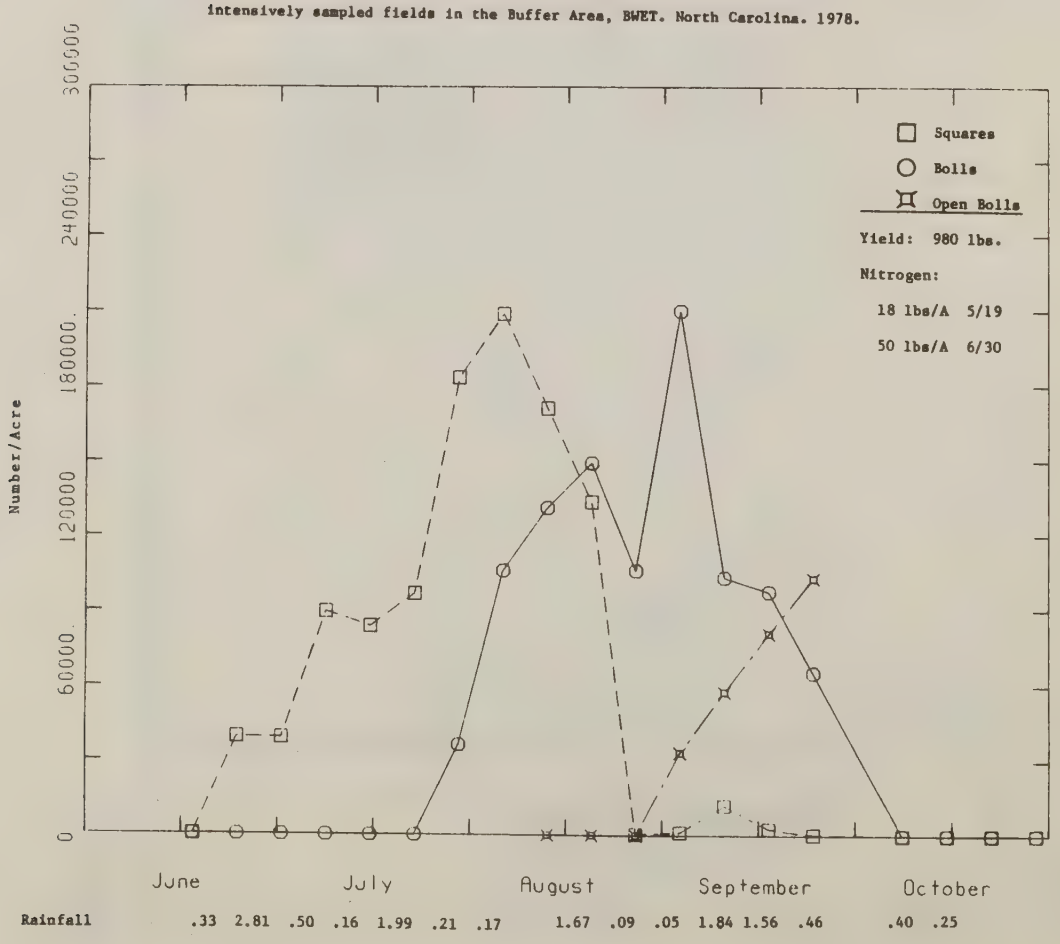
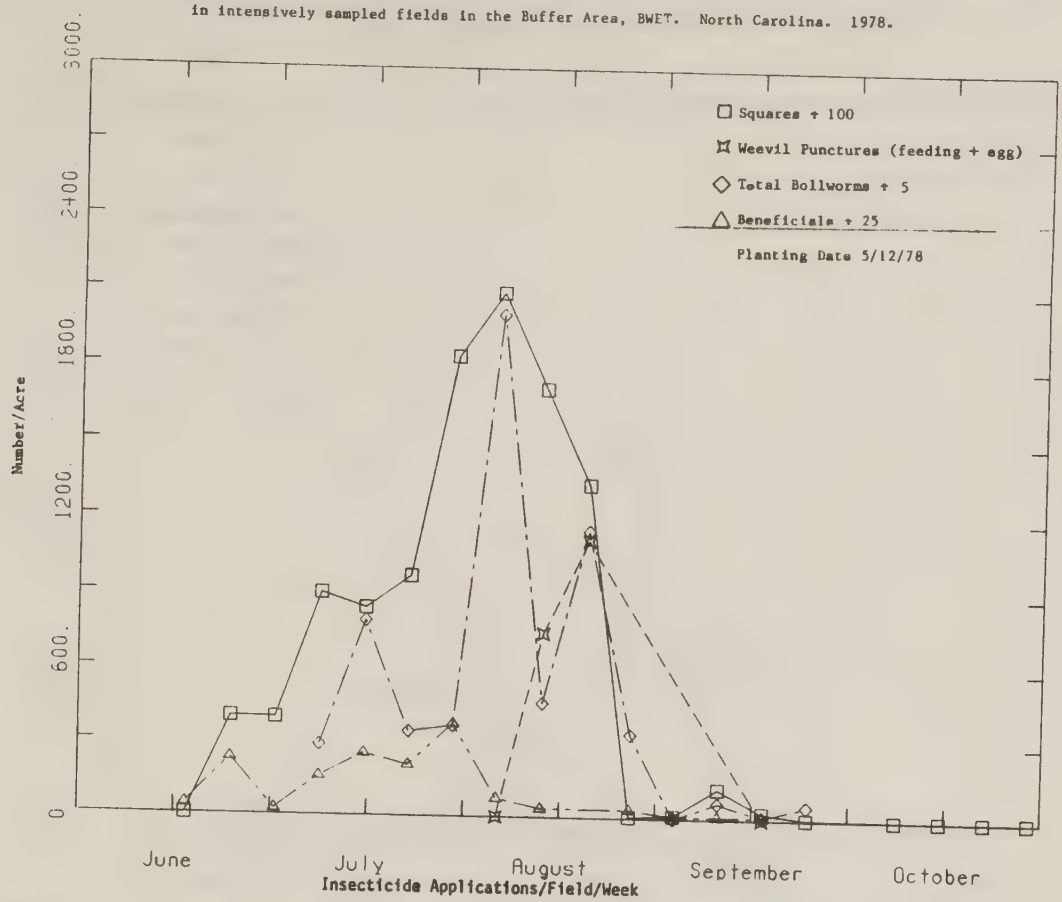


Figure 7. [illegible] no. of squares, boll weevil punctures (feeding and oviposition), total bollworms, beneficial arthropods (except predacious thrips) per acre, and no. of insecticide treatments in intensively sampled fields in the Buffer Area, BWET. North Carolina. 1978.



Insecticide Applications/Field/Week

													Total
Pyrethroid			0.13		0.13	0.13	0.25						.64
Chlordimeform	0.75	0.25											1.00
Organophosphates (± toxaphene)	0.25	1.12	1.87	1.12	1.50	.87	1.37	0.62		0.50		.25	9.47
Methomyl	0.25	0.13		0.13	0.37		0.38	0.13	0.50				1.89
													13.00

Figure 8. Estimated no. of bollworm damaged bolls and squares per acre in intensively sampled fields in Buffer Area, BWET. North Carolina. 1978.

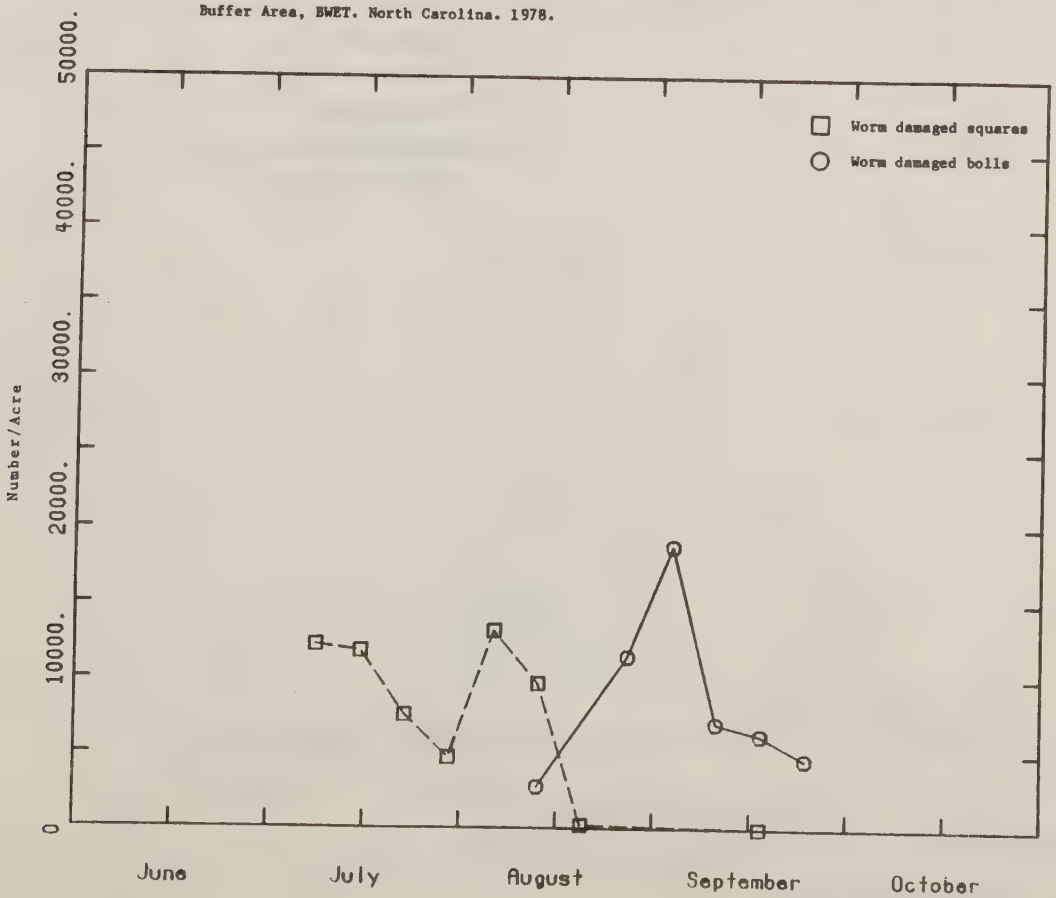


Figure 9. Estimates of squaring, boll set, boll opening, rainfall, use of nitrogen, and yield in intensively sampled fields in Chowan County, BWET. North Carolina. 1978.

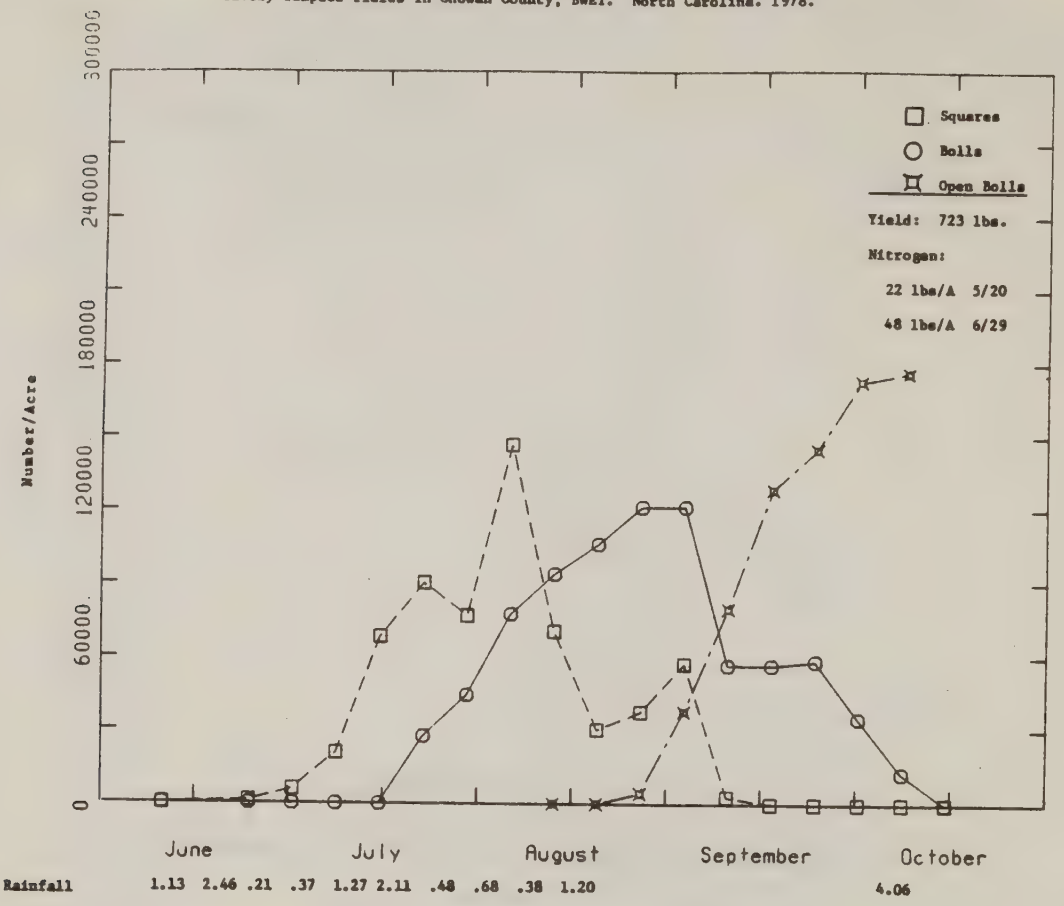
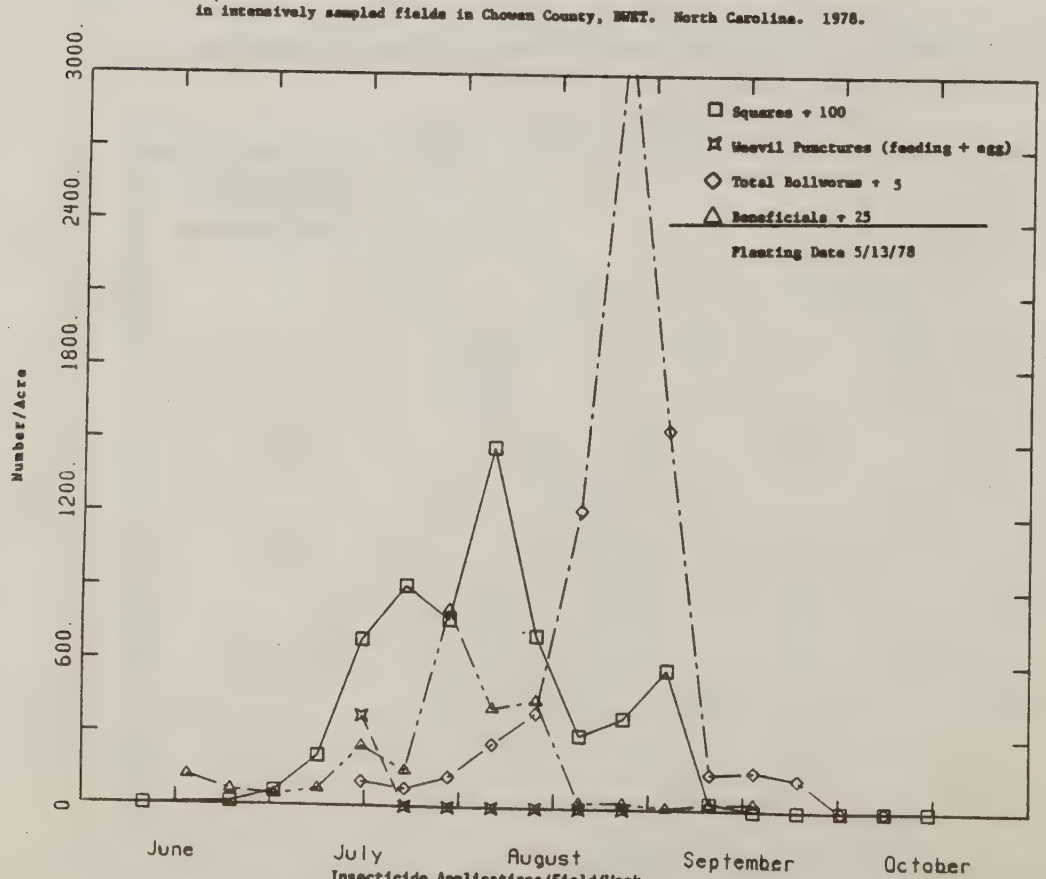


Figure 10. Estimated no. of squares, boll weevil punctures (feeding and oviposition), total bollworms, beneficial arthropods (except predacious thrips) per acre, and no. of insecticide treatments in intensively sampled fields in Chowan County, BWET. North Carolina. 1978.



Insecticide Applications/Field/Week

									Total
Organophosphate (± toxaphene)			1.00	1.00	.87	.61	1.25	1.25	0.25	6.23
Methomyl					0.13	0.39				.52
Diflubenzuron	1.00	1.00	1.00	1.00	1.00					5.00
										11.75

Figure 11. Estimated no. of bollworm damaged bolls and squares in intensively sampled fields, Chowan County, BWET. North Carolina. 1978.

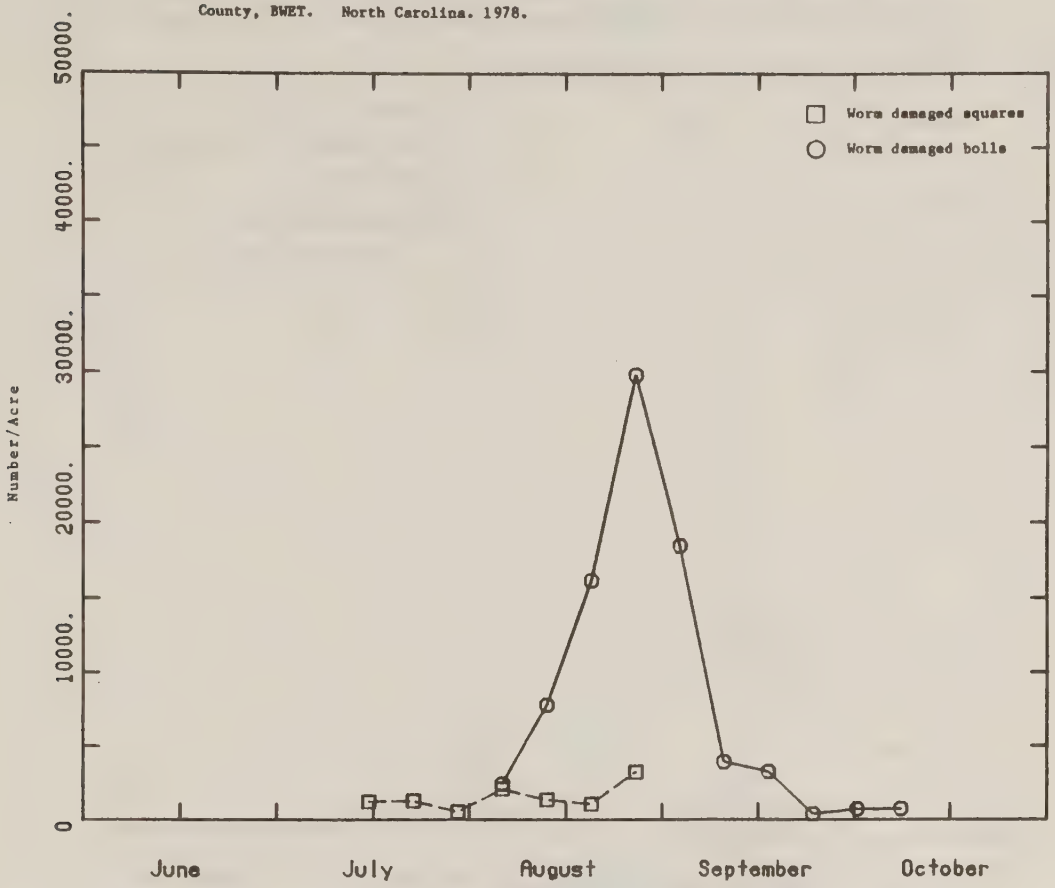


Figure 12. Estimates of squaring, boll set, boll opening, rainfall, use of nitrogen, and yield in intensively sampled fields in Scotland-Robeson counties outside BWET area. North Carolina. 1978.

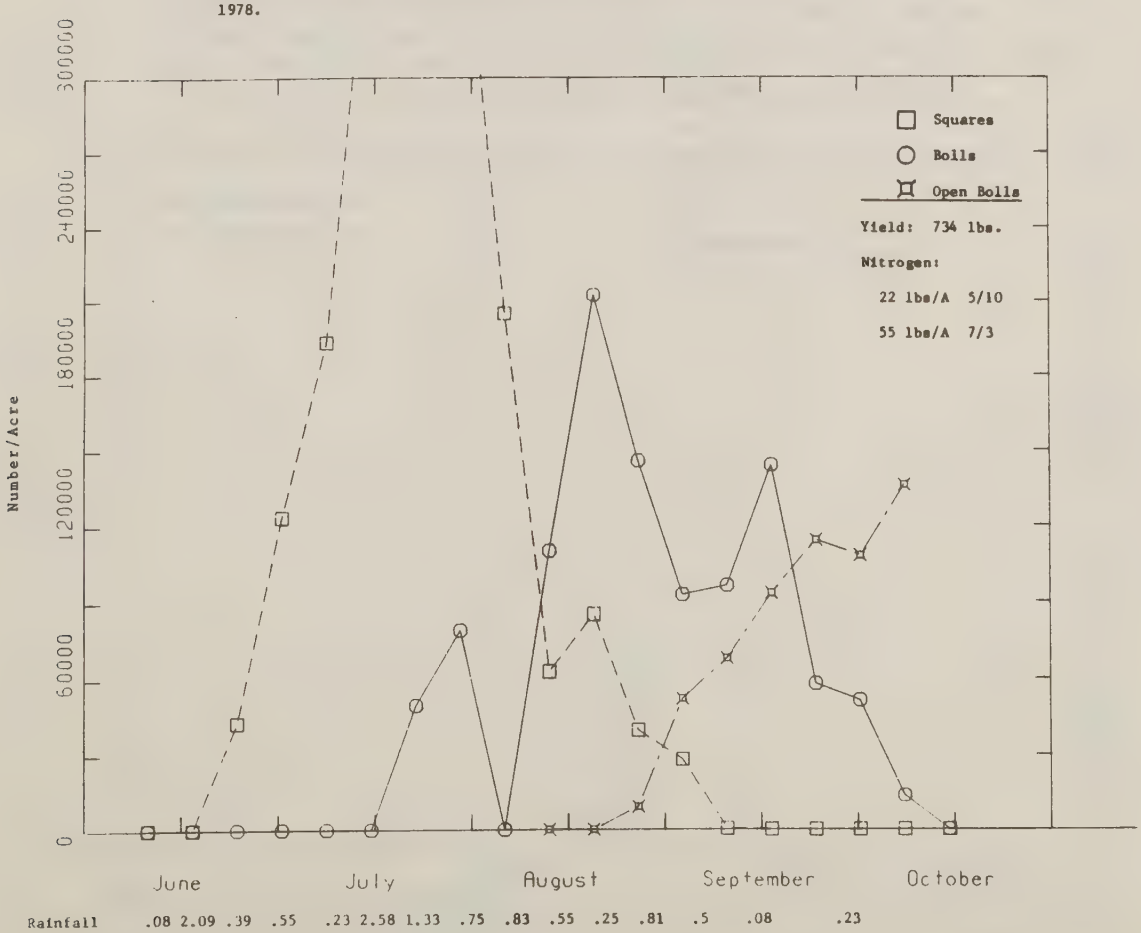
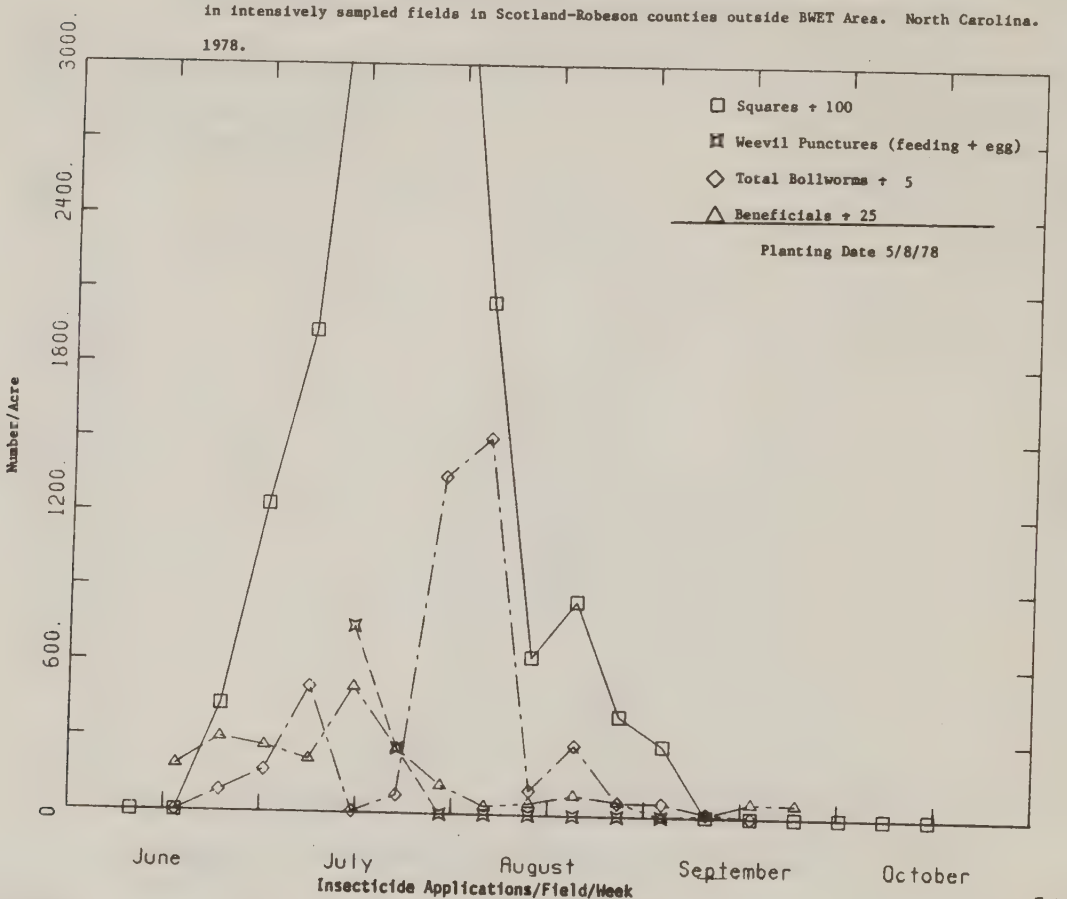


Figure 13. Estimated no. of squares, boll weevil punctures (feeding and oviposition), total bollworms, beneficial arthropods (except predacious thrips) per acre, and no. of insecticide treatments in intensively sampled fields in Scotland-Robeson counties outside BWET Area. North Carolina. 1978.



		Insecticide Applications/Field/Week								Total
Pyrethroid	0.25	0.25	1.25	0.75	0.50	0.50	0.37	0.62	0.37	4.86
Chlordimeform				0.13		0.25	0.13	0.13		.64
Organophosphates (± toxaphene)				0.37	0.50	1.00	0.37	1.00	0.25	3.49
Methomyl	0.25		0.25	0.75	0.25	0.13	0.13			1.76
										10 75

Figure 14. Estimated no. of bollworm damaged bolls and squares in intensively sampled fields in Scotland-Robeson counties outside BWET area. North Carolina. 1978.

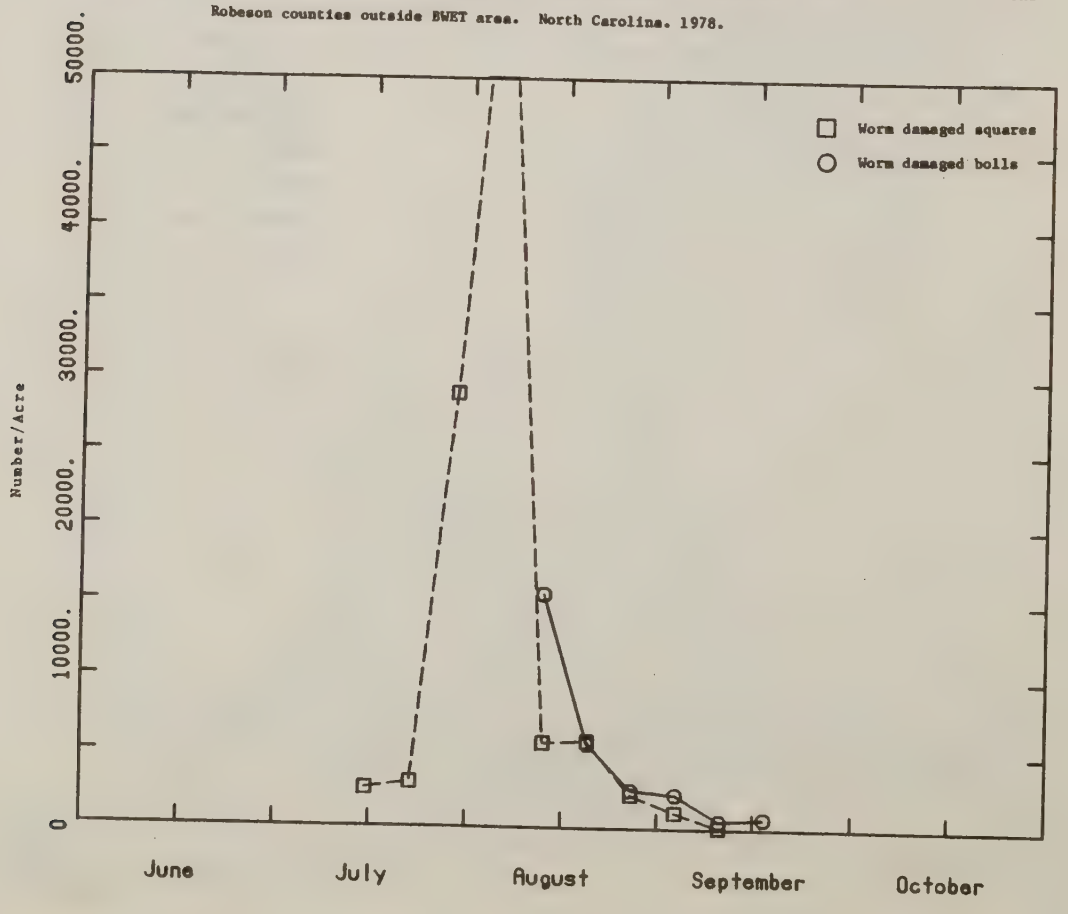


Figure 15. Estimates of squaring, boll set, boll opening, rainfall, use of nitrogen, and yield in intensively sampled fields in Cleveland County outside BWET area. North Carolina. 1978.

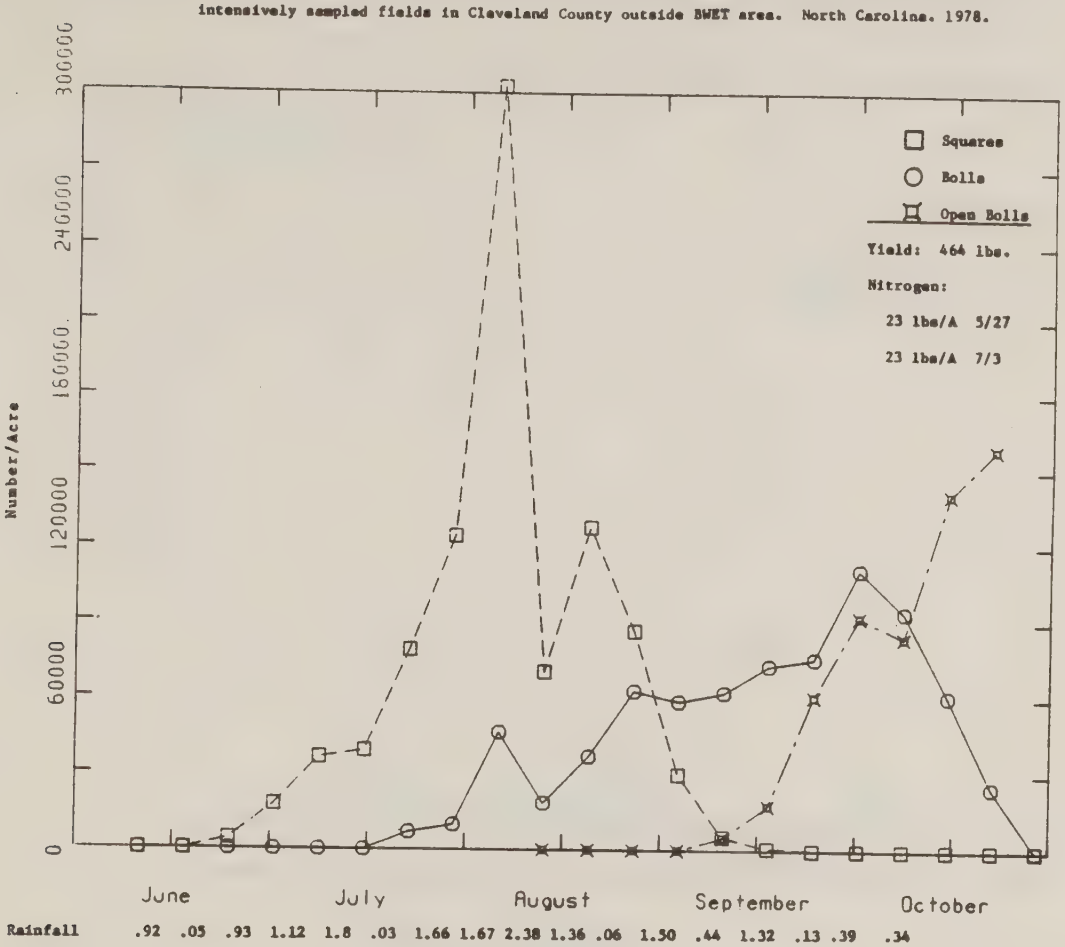
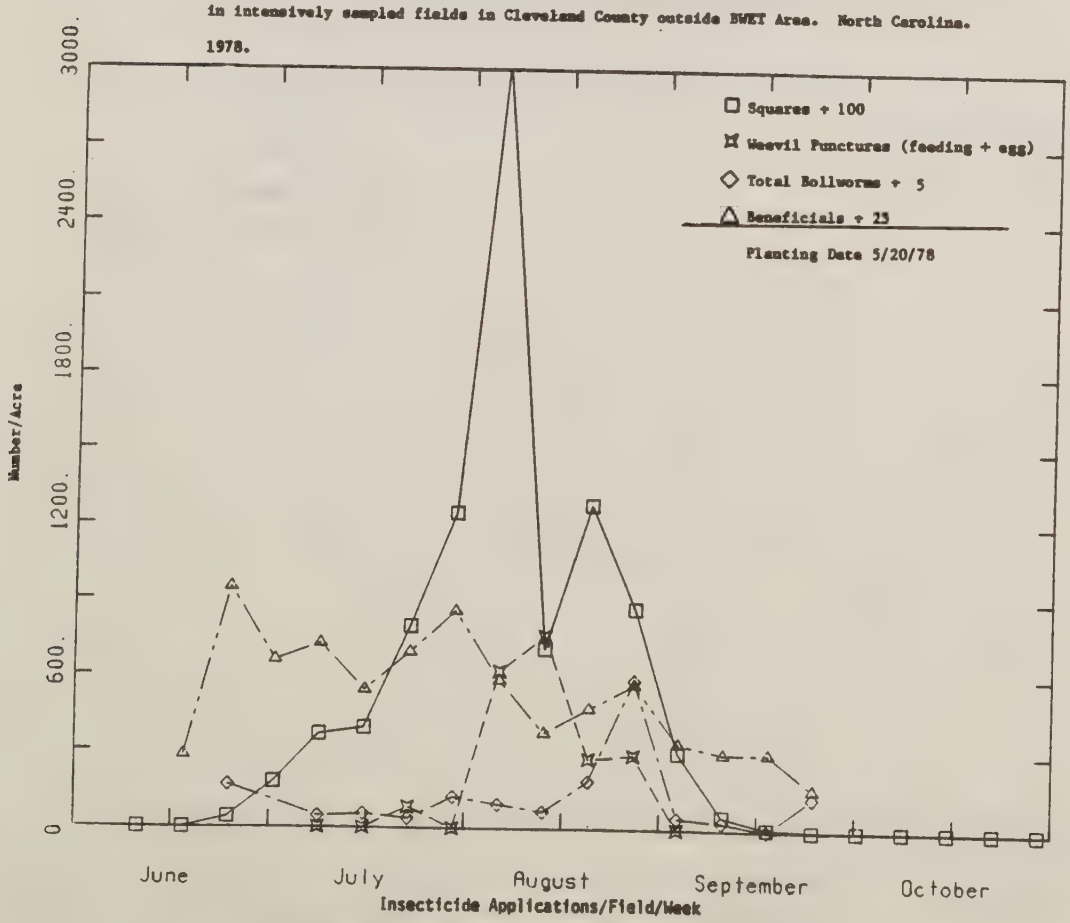


Figure 16. Estimated no. of squares, boll weevil punctures (feeding and oviposition), total bollworms, beneficial arthropods (except predacious thrips) per acre, and no. of insecticide treatments in intensively sampled fields in Cleveland County outside BWET Area. North Carolina. 1978.



Insecticides were not required for the control of cotton insects.

Figure 17. Estimated no. of bollworm damaged bolls and squares in intensively sampled fields in Cleveland County outside BWET area. North Carolina. 1978.

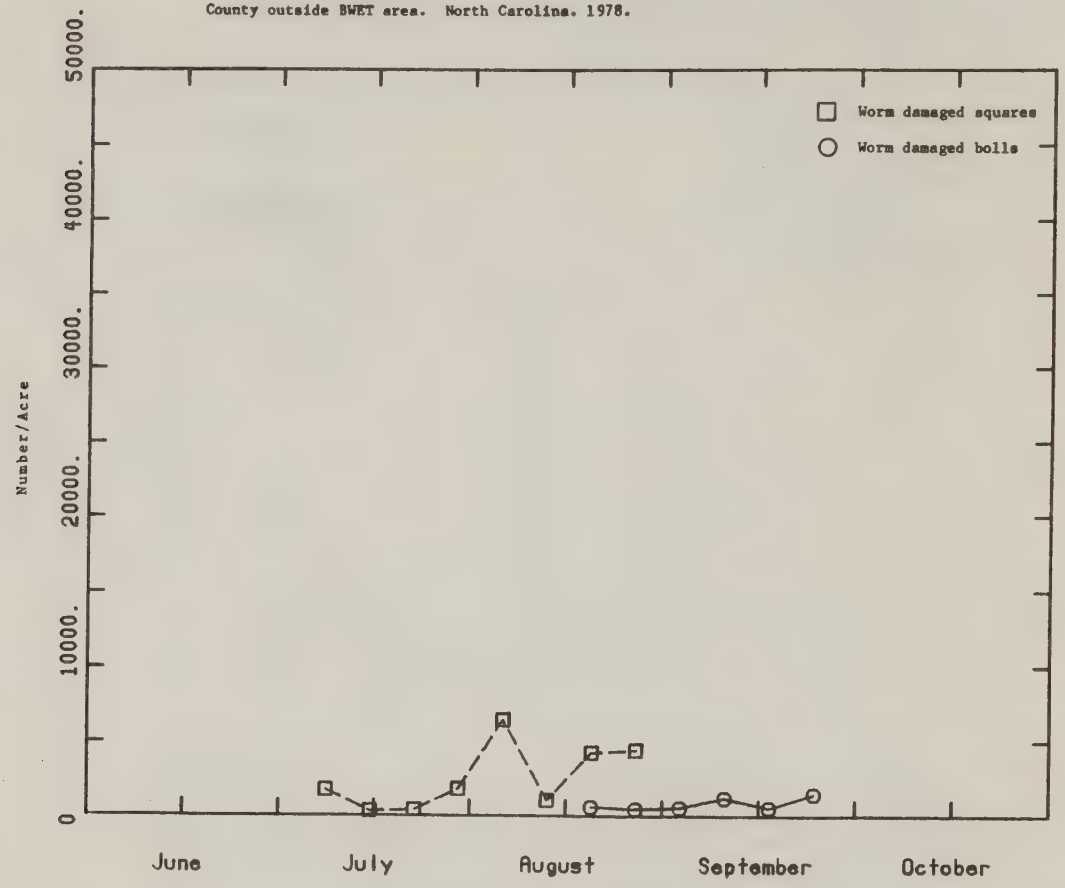


Figure 18. Estimates of squaring, boll set, boll opening, rainfall, use of nitrogen, and yield in intensively sampled fields in the Evaluation Area, BWET. North Carolina. 1979.

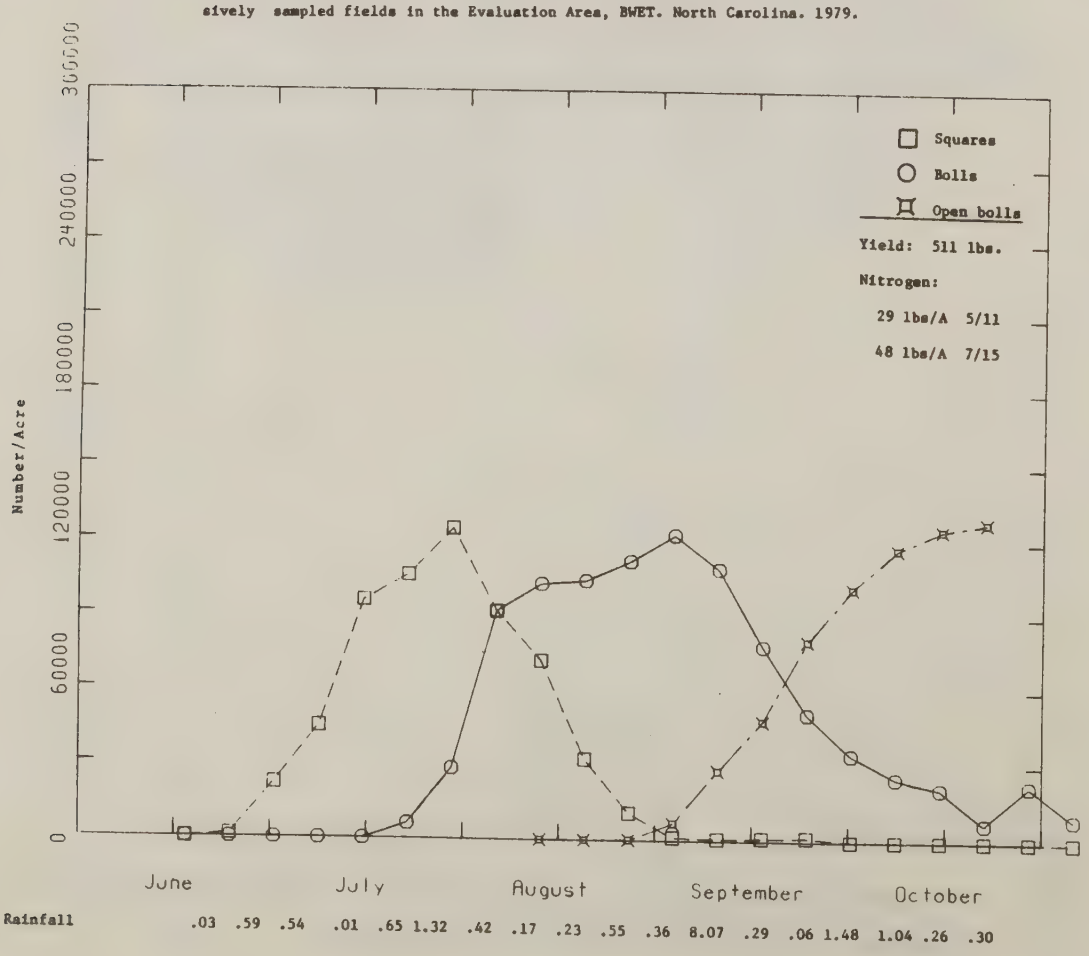


Figure 19. Estimated no. of squares, boll weevil punctures (feeding and oviposition), total bollworms, beneficial arthropods (except predacious thrips) per acre, and no. of insecticide treatments in intensively sampled fields in the Evaluation Area, BWET. North Carolina. 1979.

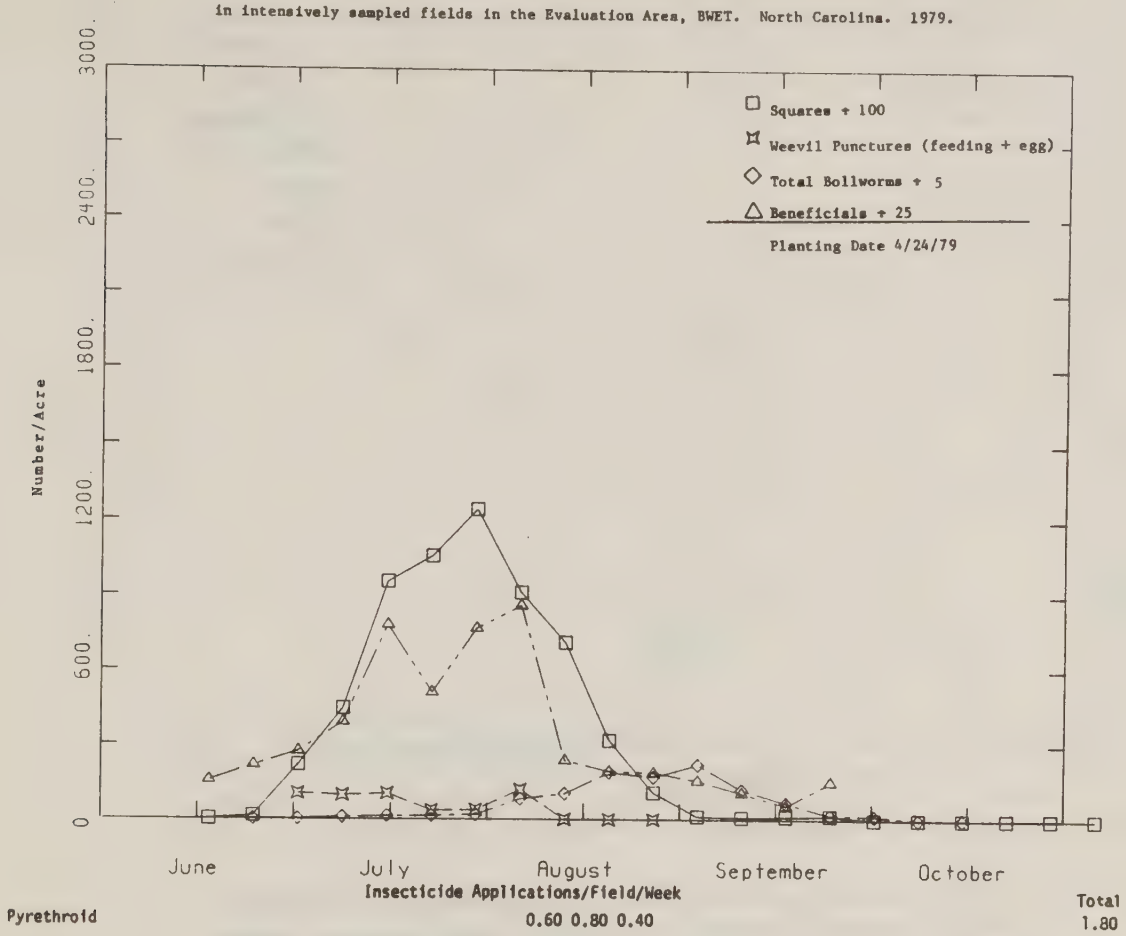


Figure 20. Estimated no. of bollworm damaged bolls and squares per acre in intensively sampled fields in Evaluation Area, BWET. North Carolina. 1979.

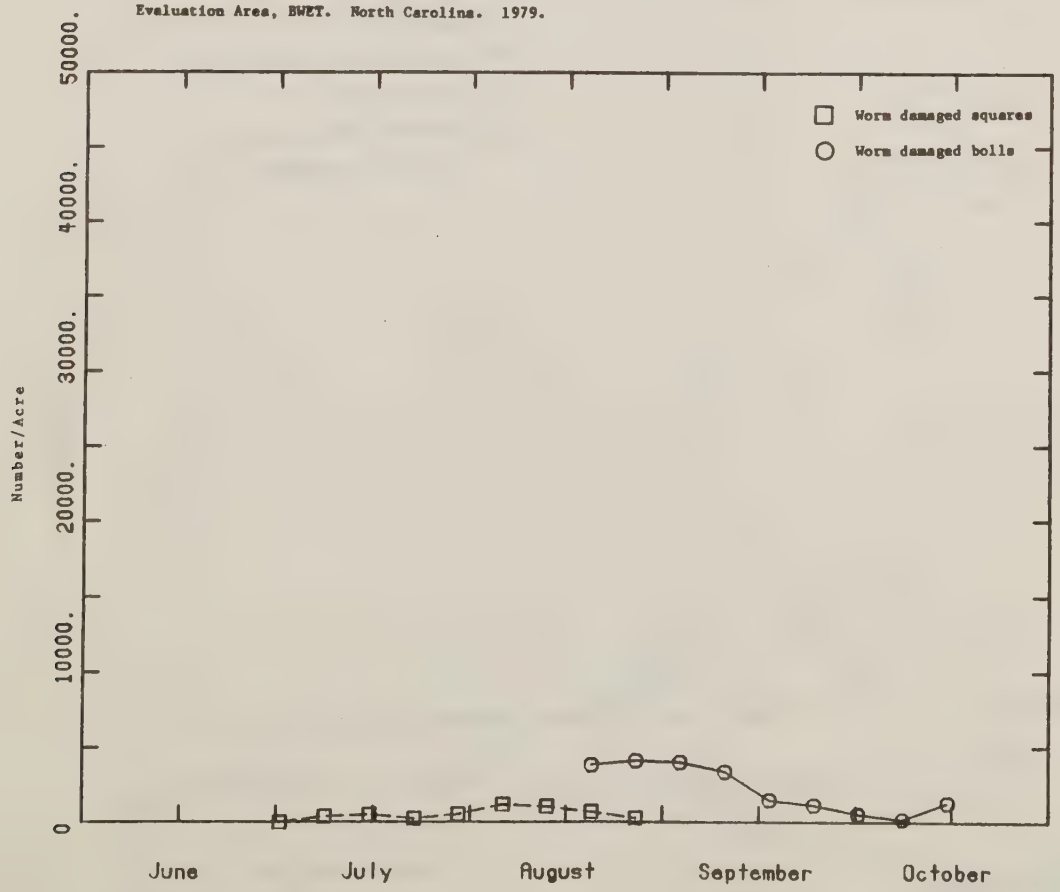


Figure 21. Estimates of squaring, boll set, boll opening, rainfall, use of nitrogen, and yield in the intensively sampled fields in the Buffer Area, BWET. North Carolina. 1979.

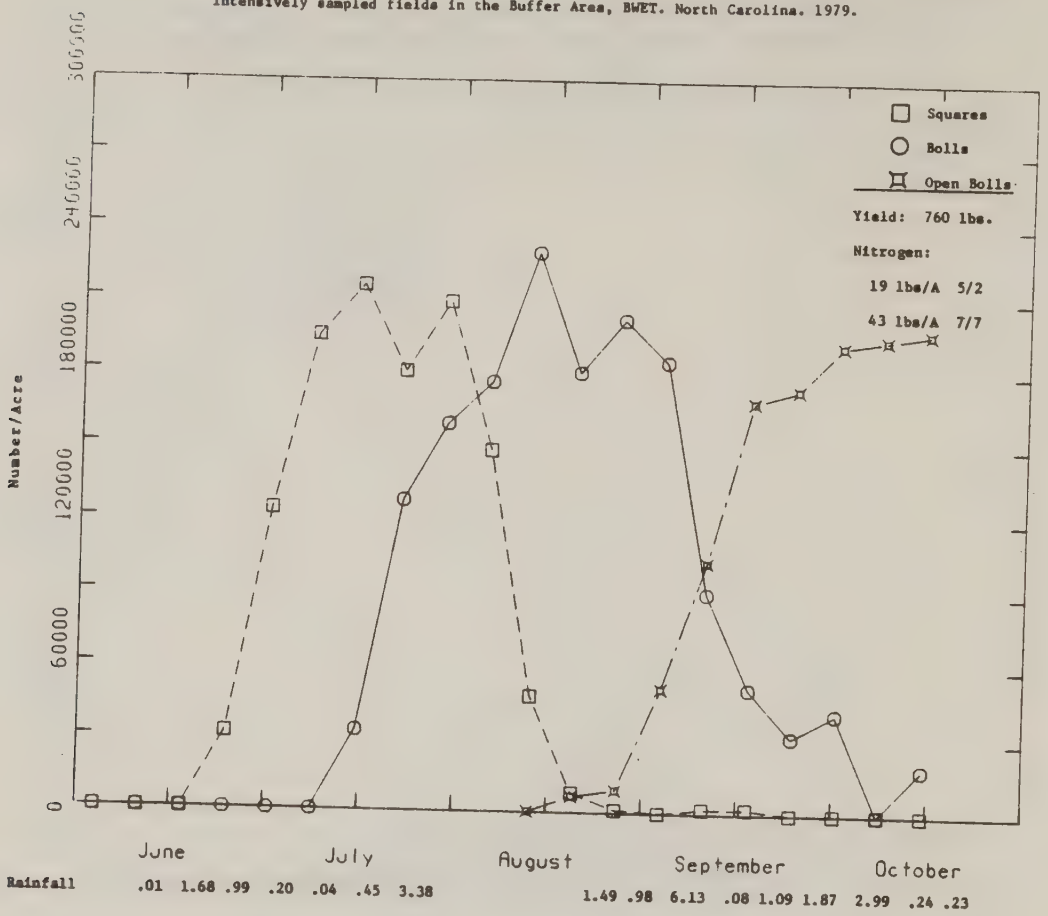
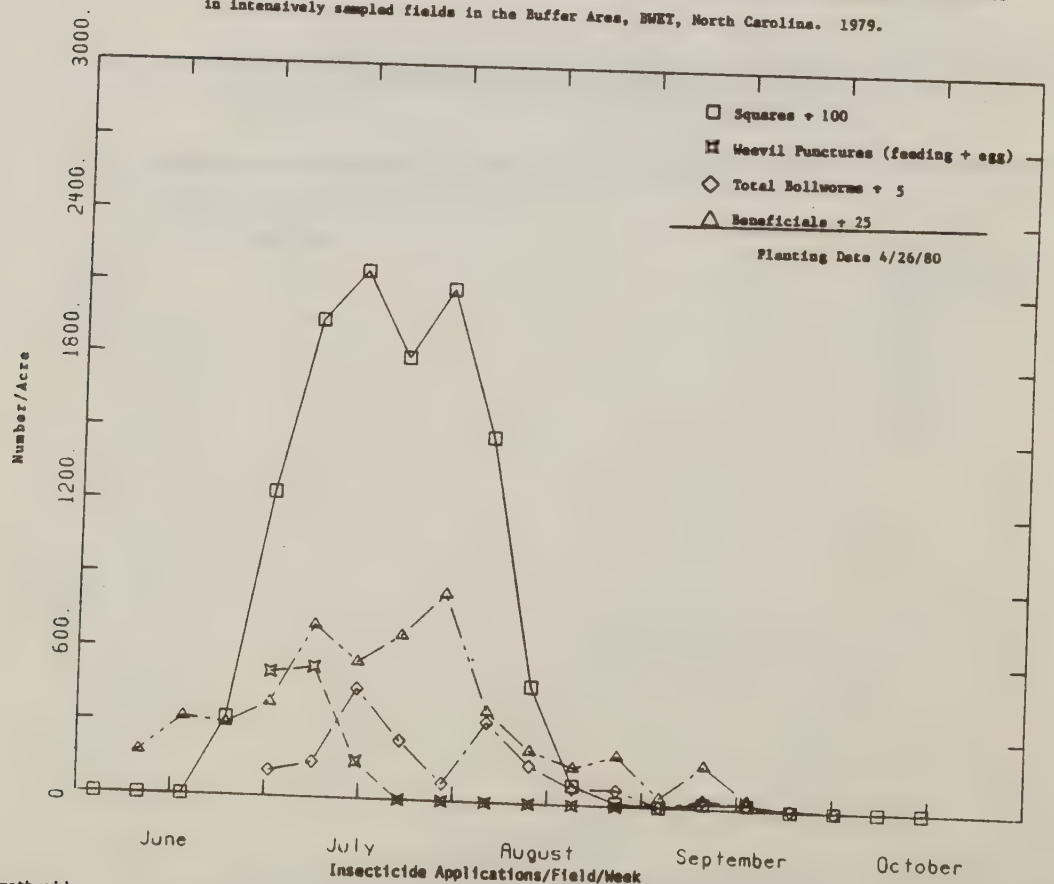


Figure 22. Estimated no. of squares, boll weevil punctures (feeding and oviposition), total bollworms, beneficial arthropods (except predacious thrips) per acre, and no. of insecticide treatments in intensively sampled fields in the Buffer Area, BWET, North Carolina. 1979.



Insecticide Applications/Field/Week

Pyrethroid			0.50	0.75	1.00	1.00	1.00	1.00
Chlordimeform			0.37	0.75				
Organophosphate								
Diflubenzuron	0.25	0.25	0.25	0.25				
Bac. thur.								

								Total
Pyrethroid								5.25
Chlordimeform								1.12
Organophosphate					0.75	0.50	0.50	1.00	1.50	4.25
Diflubenzuron										1.00
Bac. thur.			0.38	0.75						1.13
										12.75

Figure 23. Estimated no. of bollworm damaged bolls and squares in intensively sampled fields in Buffer Area, BWET. North Carolina. 1979.

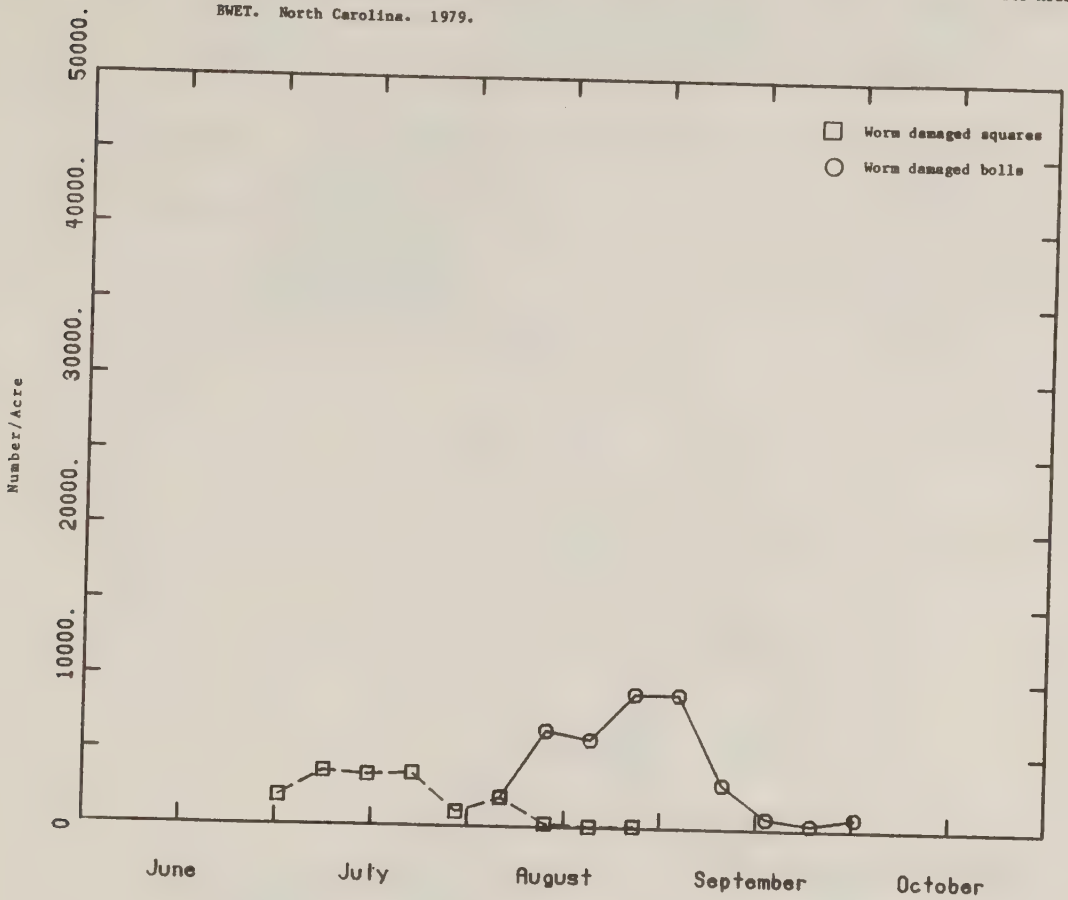


Figure 24. Estimates of squaring, boll set, boll opening, rainfall, use of nitrogen, and yield in intensively sampled fields in Chowan County, BWET. North Carolina. 1979.

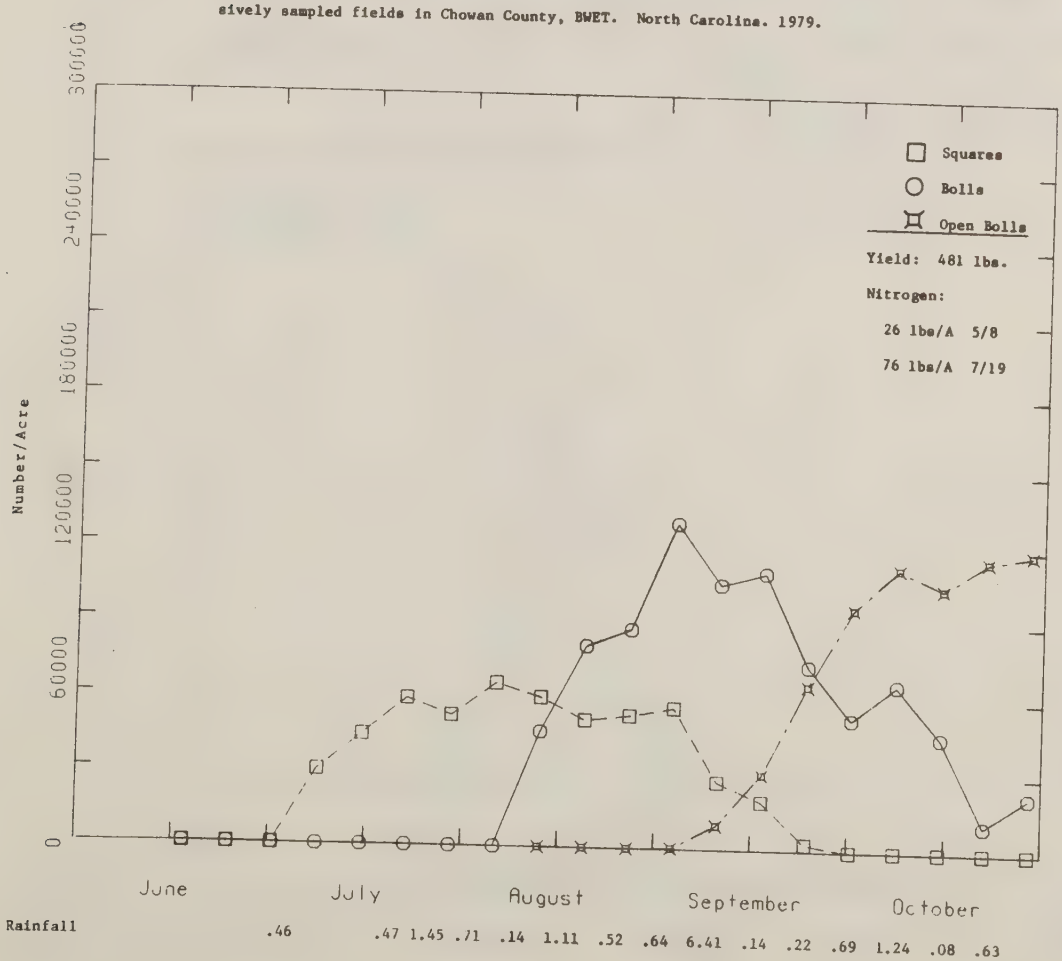


Figure 25. Estimated no. of squares, boll weevil punctures (feeding and oviposition), total bollworms, beneficial arthropods (except predacious thrips) per acre, and no. of insecticide treatments in intensively sampled fields in Chowan County, BWET, North Carolina. 1979.

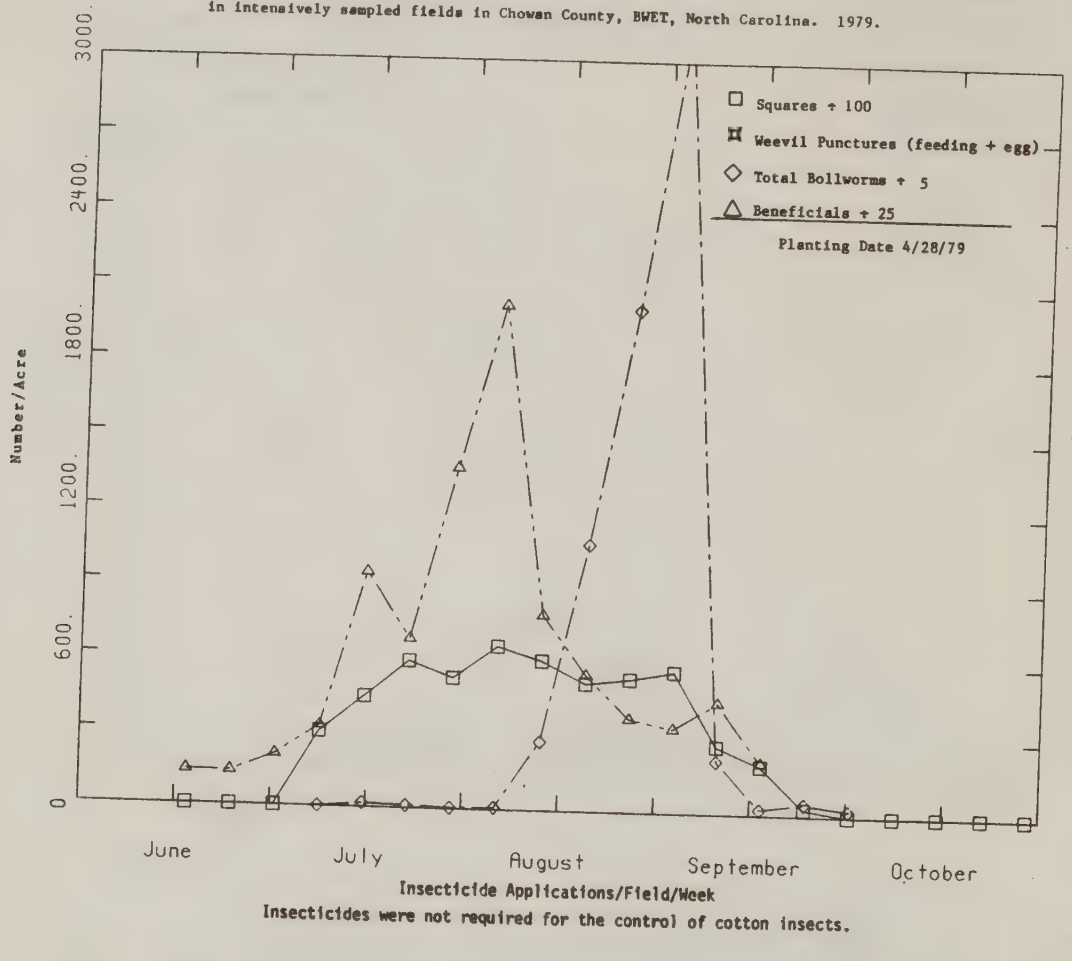


Figure 26. Estimated no. of bollworm damaged bolls and squares in intensively sampled fields, Chowan County, BWET. North Carolina. 1979.

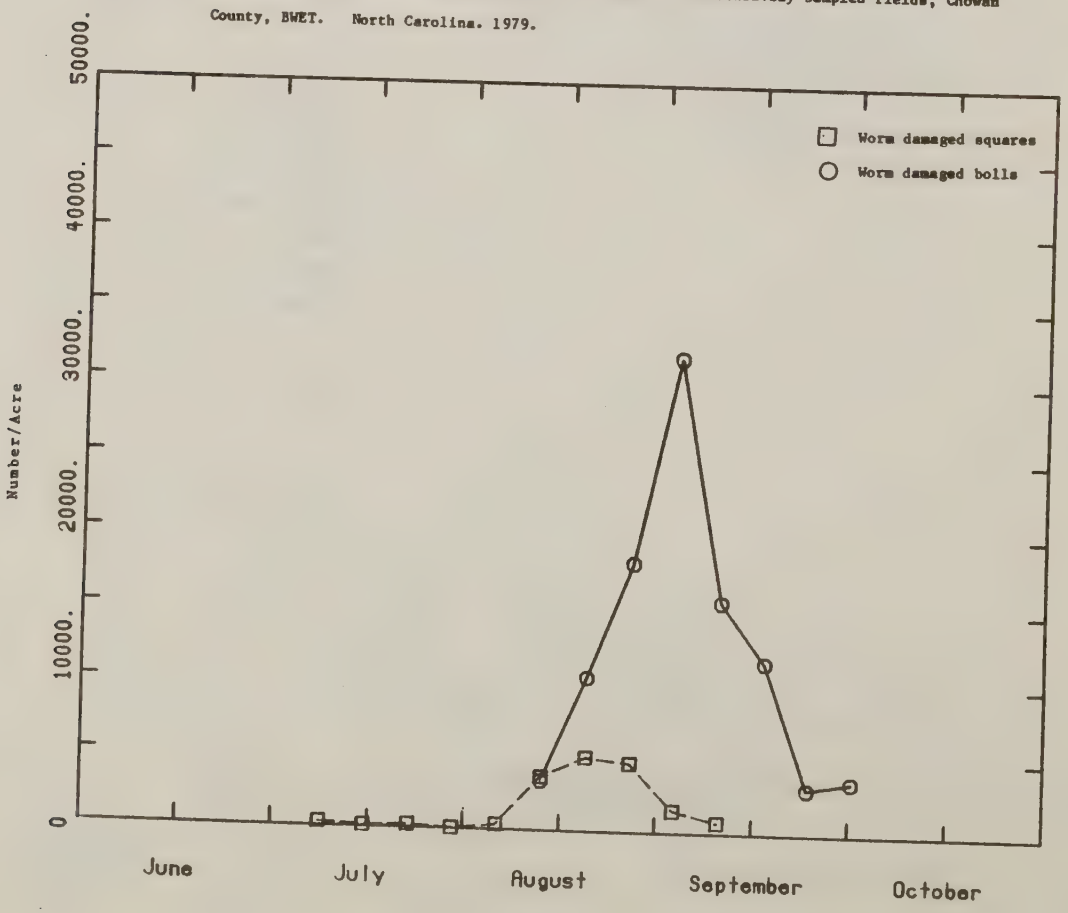


Figure 27. Estimates of squaring, boll set, boll opening, rainfall, use of nitrogen, and yield in intensively sampled fields in Scotland-Robeson counties outside BWET area. North Carolina. 1979.

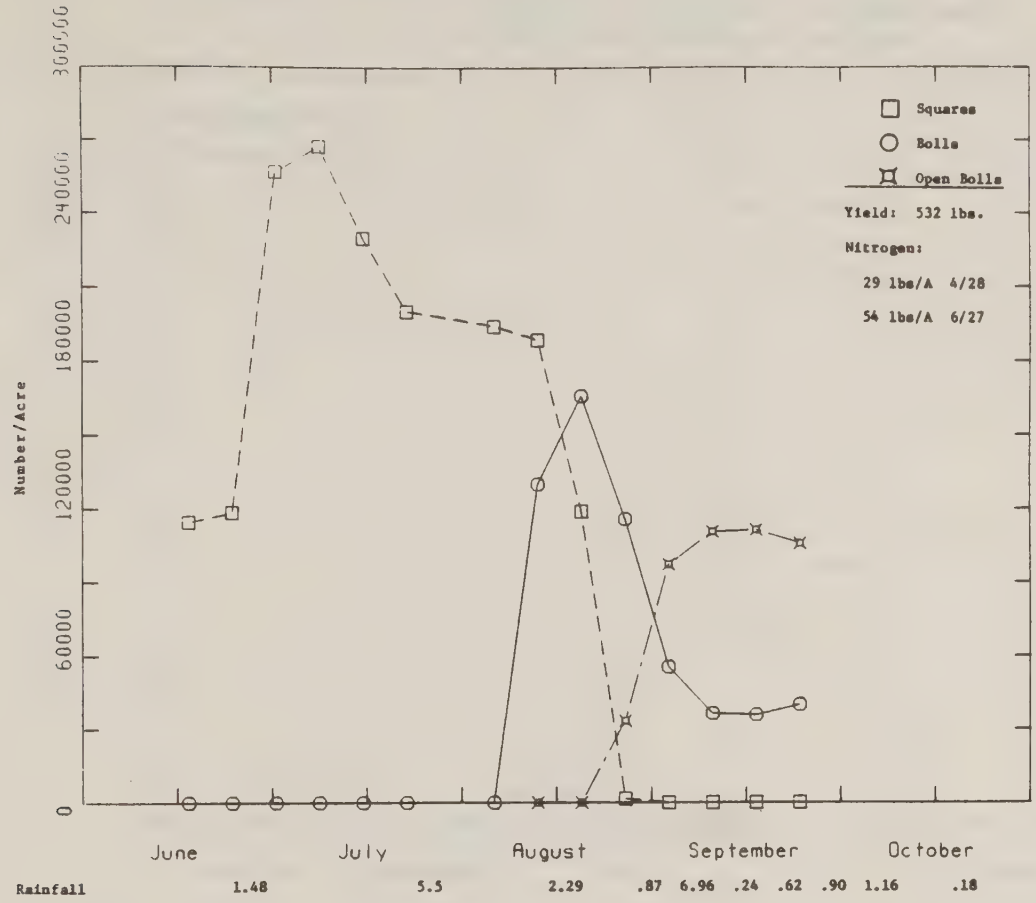
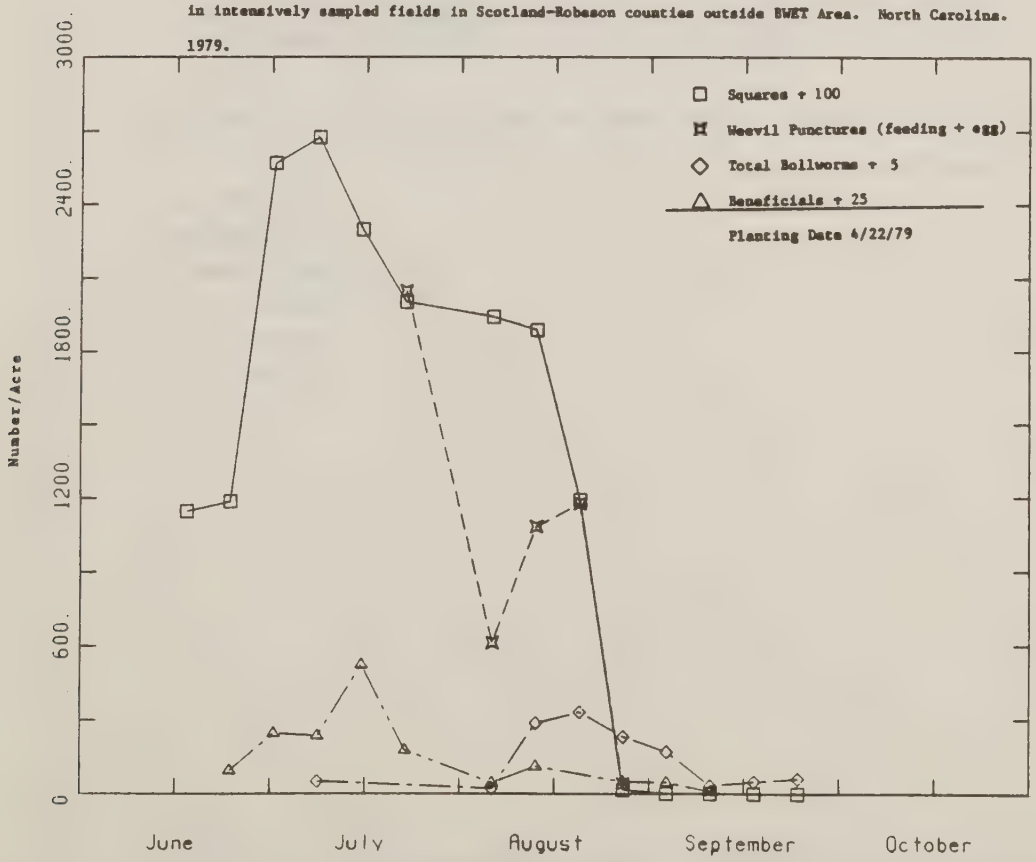


Figure 28. Estimated no. of squares, boll weevil punctures (feeding and oviposition), total bollworms, beneficial arthropods (except predacious thrips) per acre, and no. of insecticide treatments in intensively sampled fields in Scotland-Robeson counties outside BWET Area. North Carolina. 1979.



Insecticide Applications/Field/Week

														Total
Pyrethroid		.38	.50	.63	.75	.75	.50	.25	.25					4.01
Chlordimeform	.25	.13		.13		.13	.25		.25	.06	.06	.06		1.32
Organophosphate (± toxaphene)						.13			.75	.44	.19	.44	.25	2.20
														7.53

Figure 29. Estimated no. of bollworm damaged bolls and squares in intensively sampled fields in Scotland-Robeson counties outside BWET area. North Carolina. 1979.

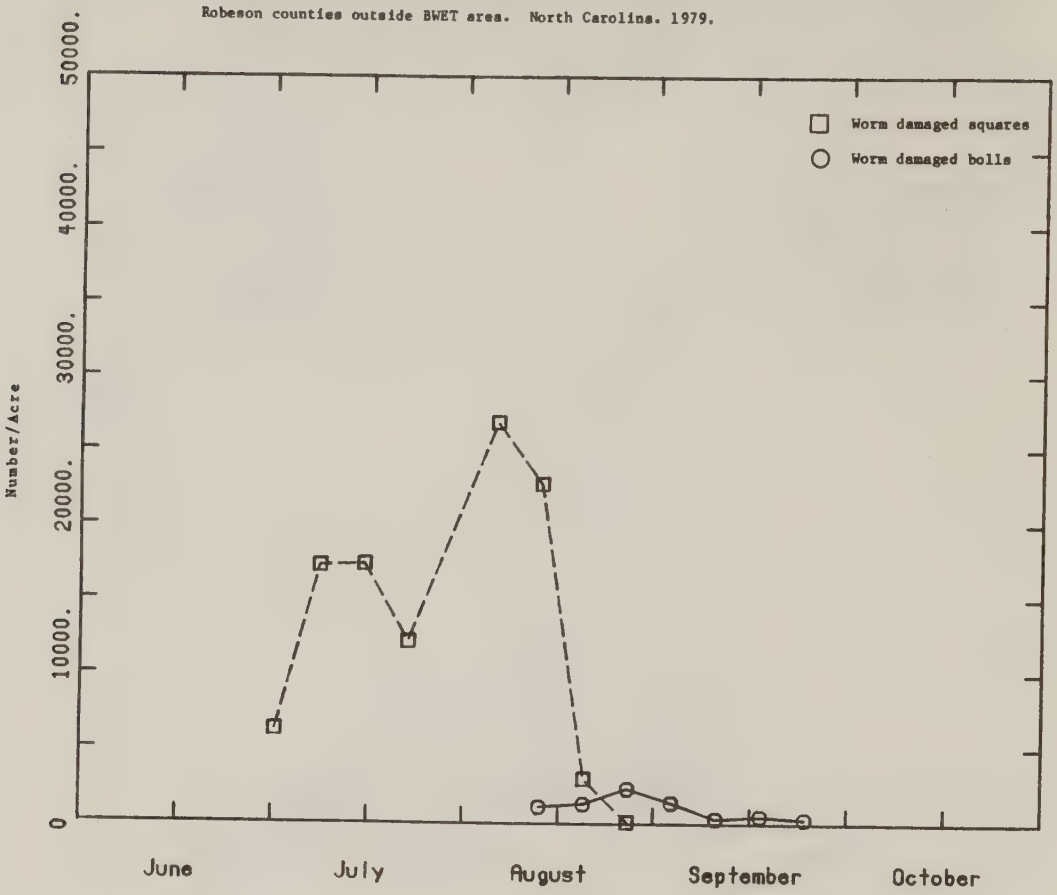


Figure 30. Estimates of squaring, boll set, boll opening, rainfall, use of nitrogen, and yield in intensively sampled fields in Cleveland County outside BWET area. North Carolina. 1979.

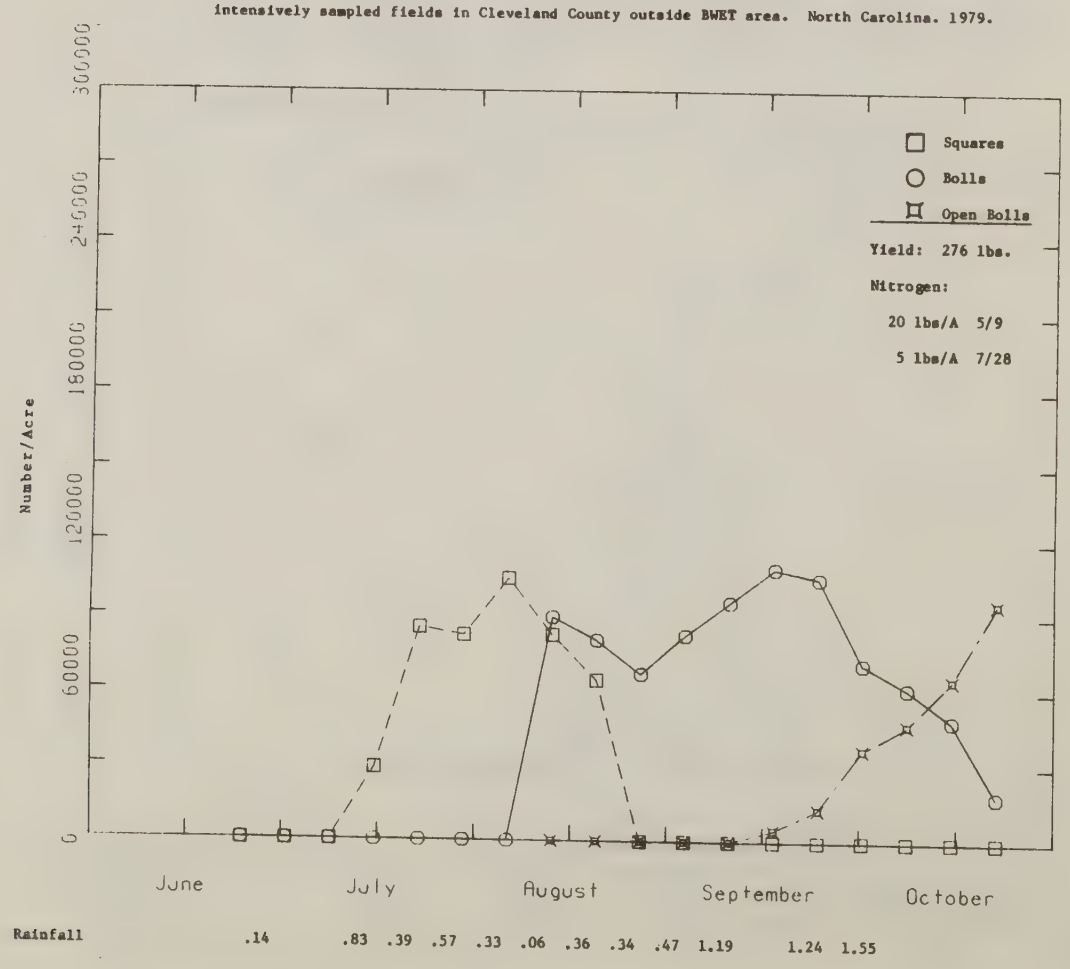
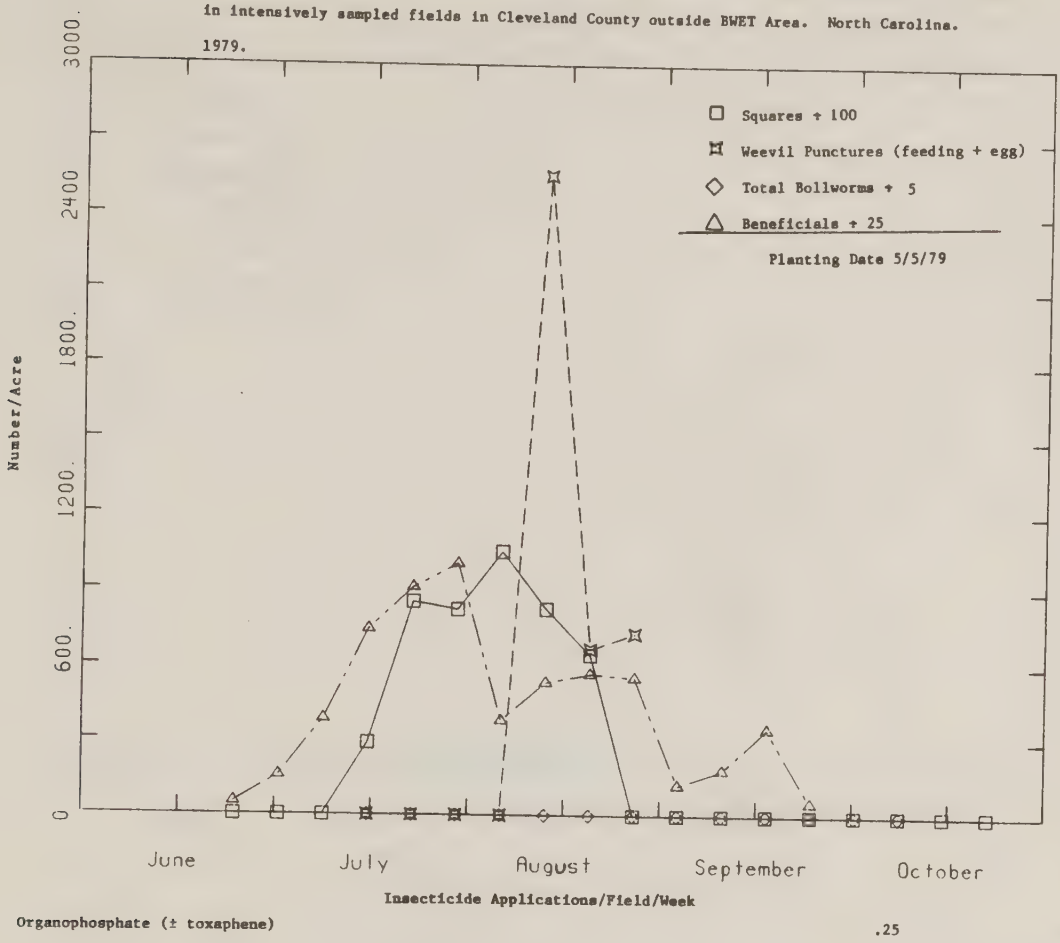


Figure 31. Estimated no. of squares, boll weevil punctures (feeding and oviposition), total bollworms, beneficial arthropods (except predacious thrips) per acre, and no. of insecticide treatments in intensively sampled fields in Cleveland County outside BWET Area. North Carolina. 1979.



Insecticide Applications/Field/Week

		Total
Organophosphate (± toxaphene)	.25	.50 .75

Figure 32. Estimated no. of bollworm damaged bolls and squares in intensively sampled fields in Cleveland County outside BWET area. North Carolina. 1979.

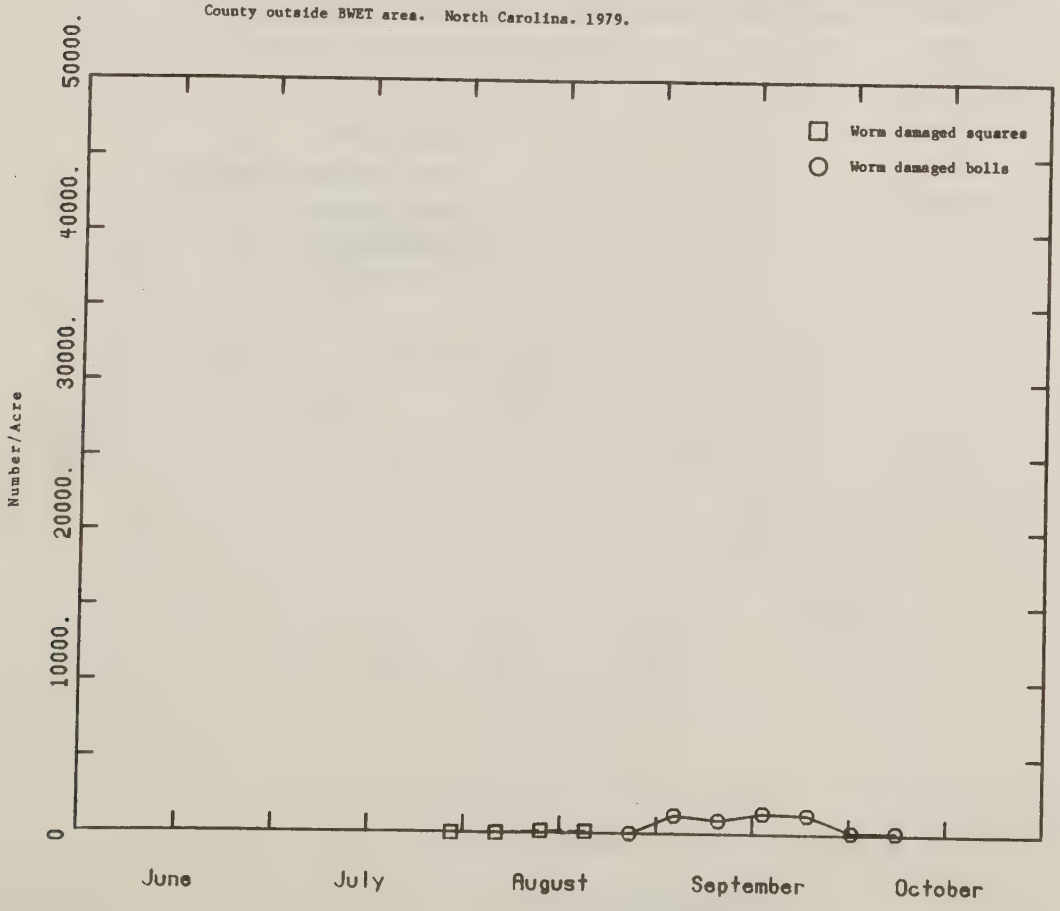
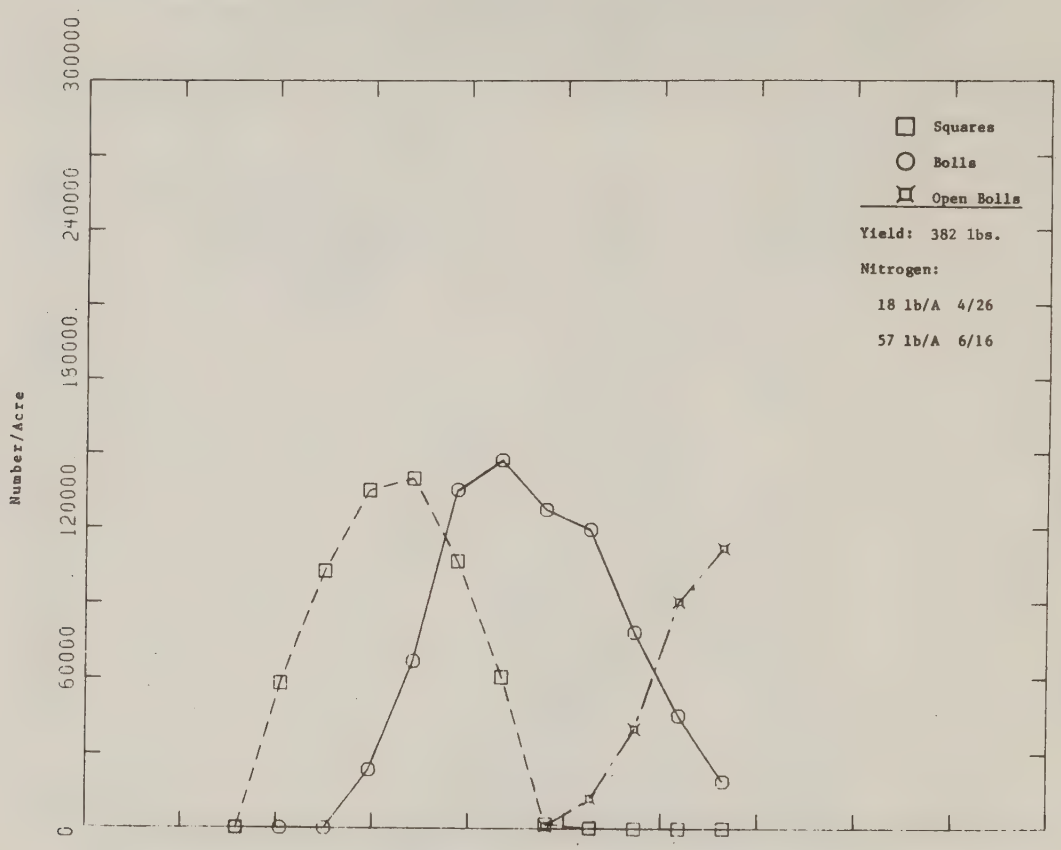
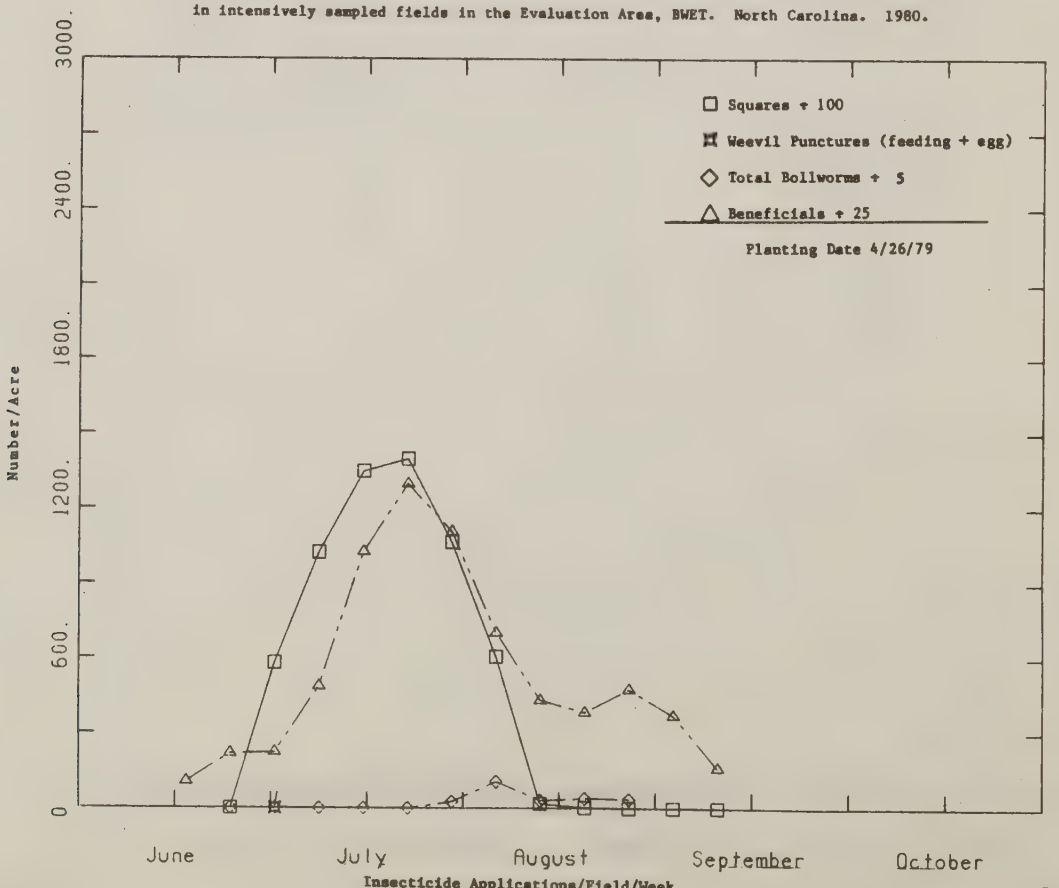


Figure 33. Estimates of squaring, boll set, boll opening, rainfall, use of nitrogen, and yield in intensively sampled fields in the Evaluation Area, BWET. North Carolina. 1980.



Rainfall .68 .39 1.06 .60 1.02 .43 .58 .06 .05 .05 .69 1.08 .01 .30

Figure 34. Estimated no. of squares, boll weevil punctures (feeding and oviposition), total bollworms, beneficial arthropods (except predacious thrips) per acre, and no. of insecticide treatments in intensively sampled fields in the Evaluation Area, BWET. North Carolina. 1980.



Insecticide Applications/Field/Week

Pyrethroid .13 .38 .62 .38 Total 1.51

Figure 35. Estimated no. of bollworm damaged bolls and squares per acre in intensively sampled fields in Evaluation Area, BWET. North Carolina. 1980.

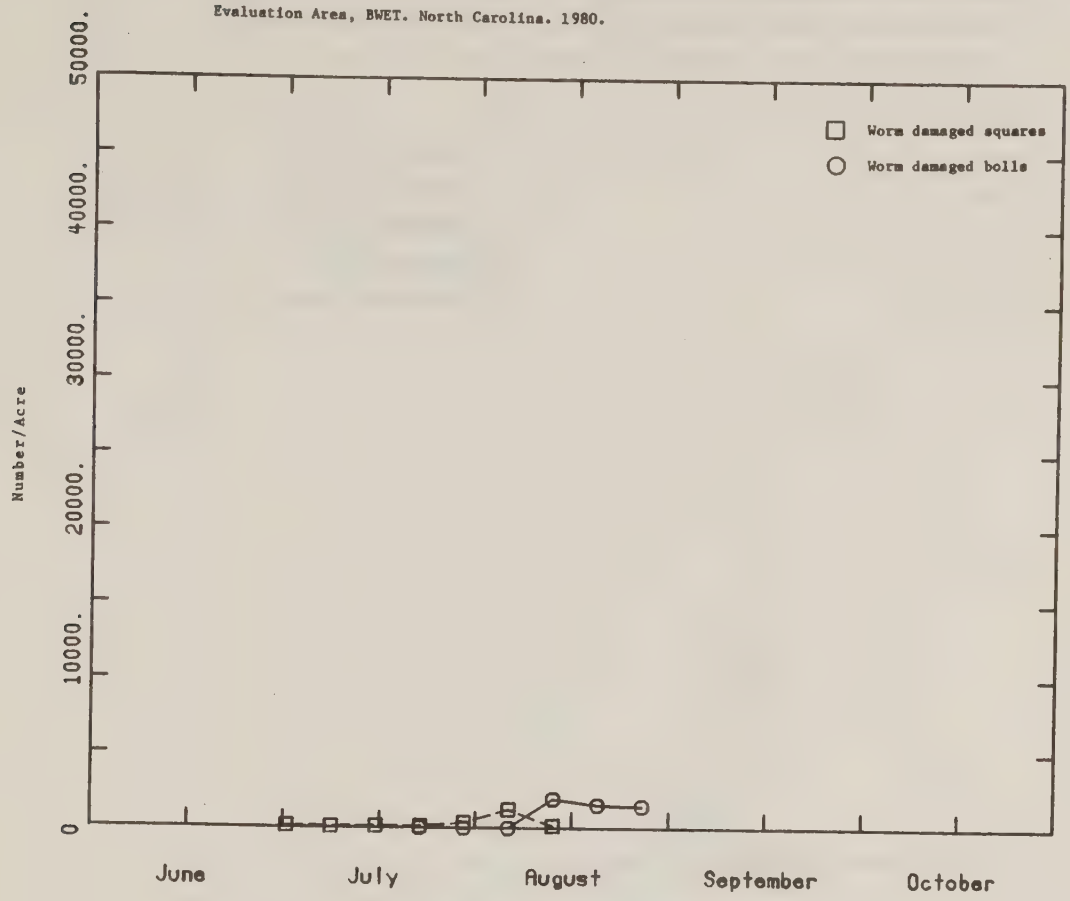


Figure 36. Estimates of squaring, boll set, boll opening, rainfall, use of nitrogen, and yield in the intensively sampled fields in the Buffer Area, BWET. North Carolina. 1980.

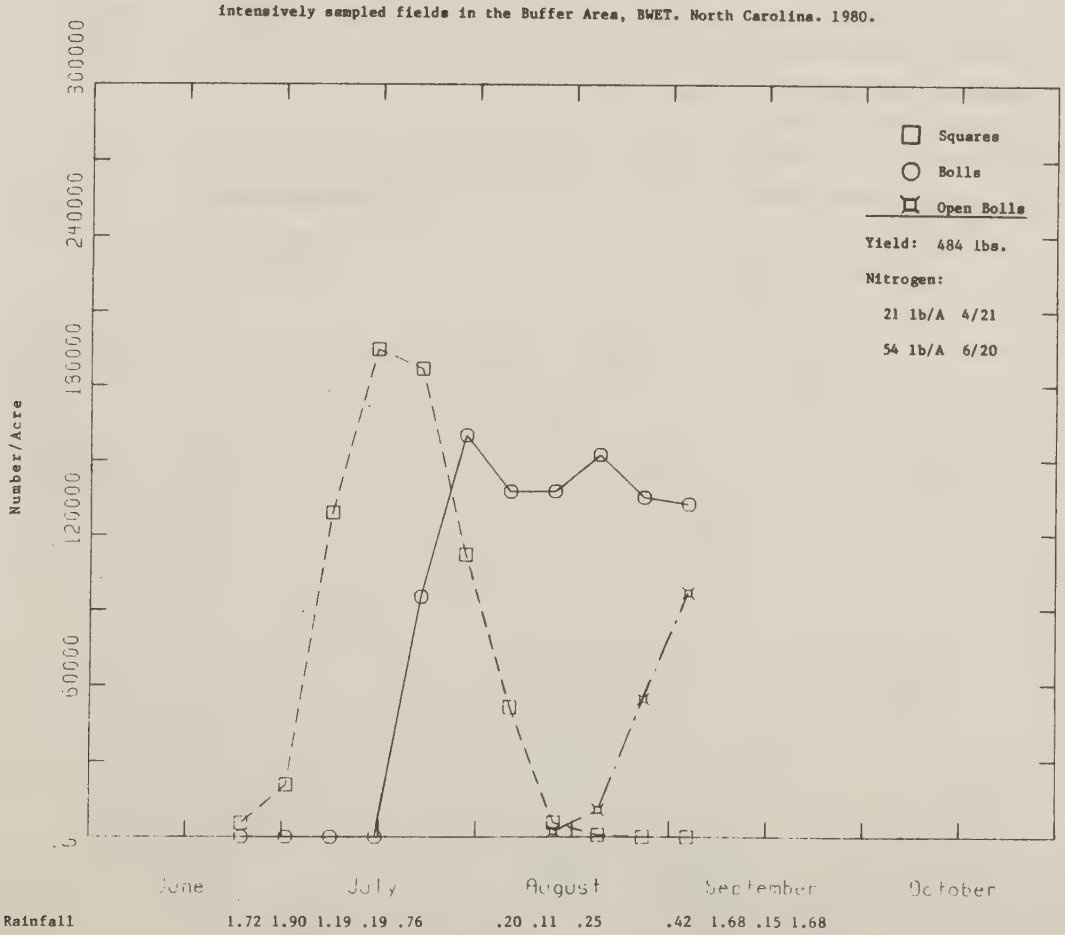
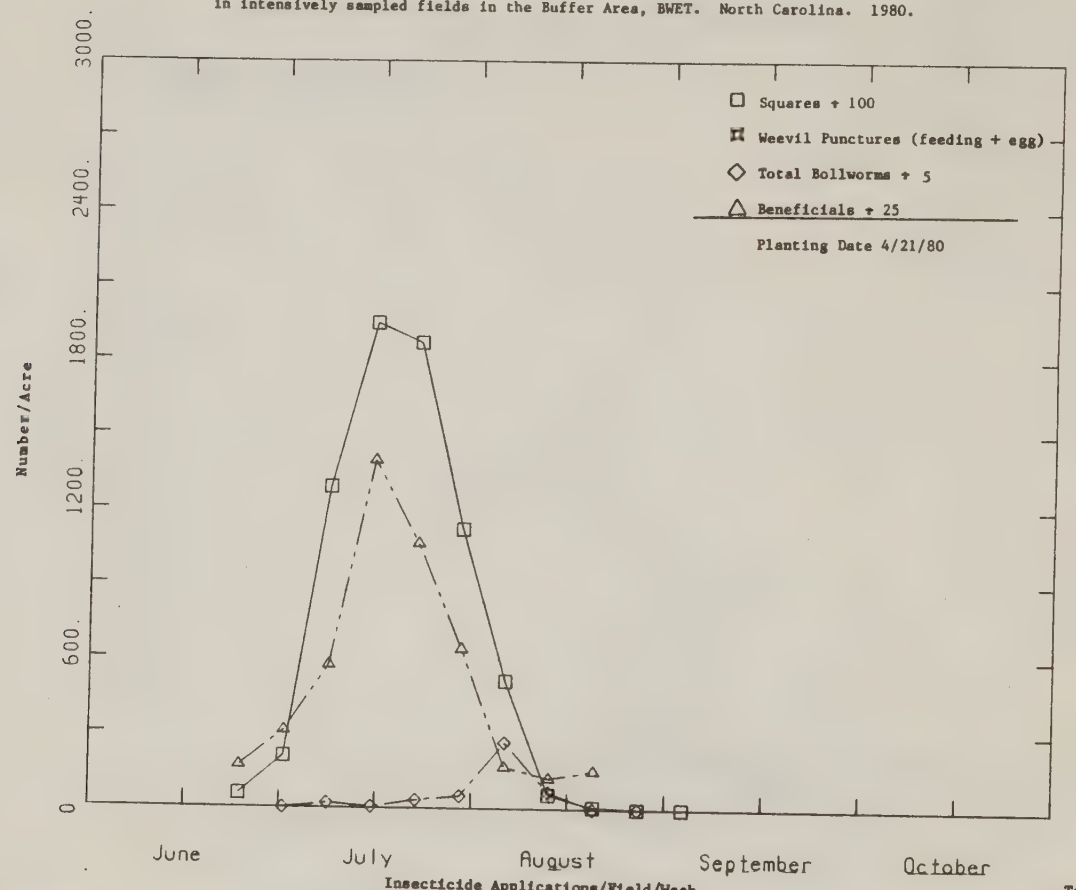


Figure 37. Estimated no. of squares, boll weevil punctures (feeding and oviposition), total bollworms, beneficial arthropods (except predacious thrips) per acre, and no. of insecticide treatments in intensively sampled fields in the Buffer Area, BWET. North Carolina. 1980.



	Insecticide Applications/Field/Week									Total
Pyrethroid			.50	1.00	.75	.50				2.75
Calordimeform		.25	1.00	.50	.25					2.00
Organophosphates (± toxaphene)	.25						1.00	1.00	1.00	4.25
										9.00

Figure 38. Estimated no. of bollworm damaged bolls and squares per acre in intensively sampled fields in Buffer Area, BWET. North Carolina. 1980.

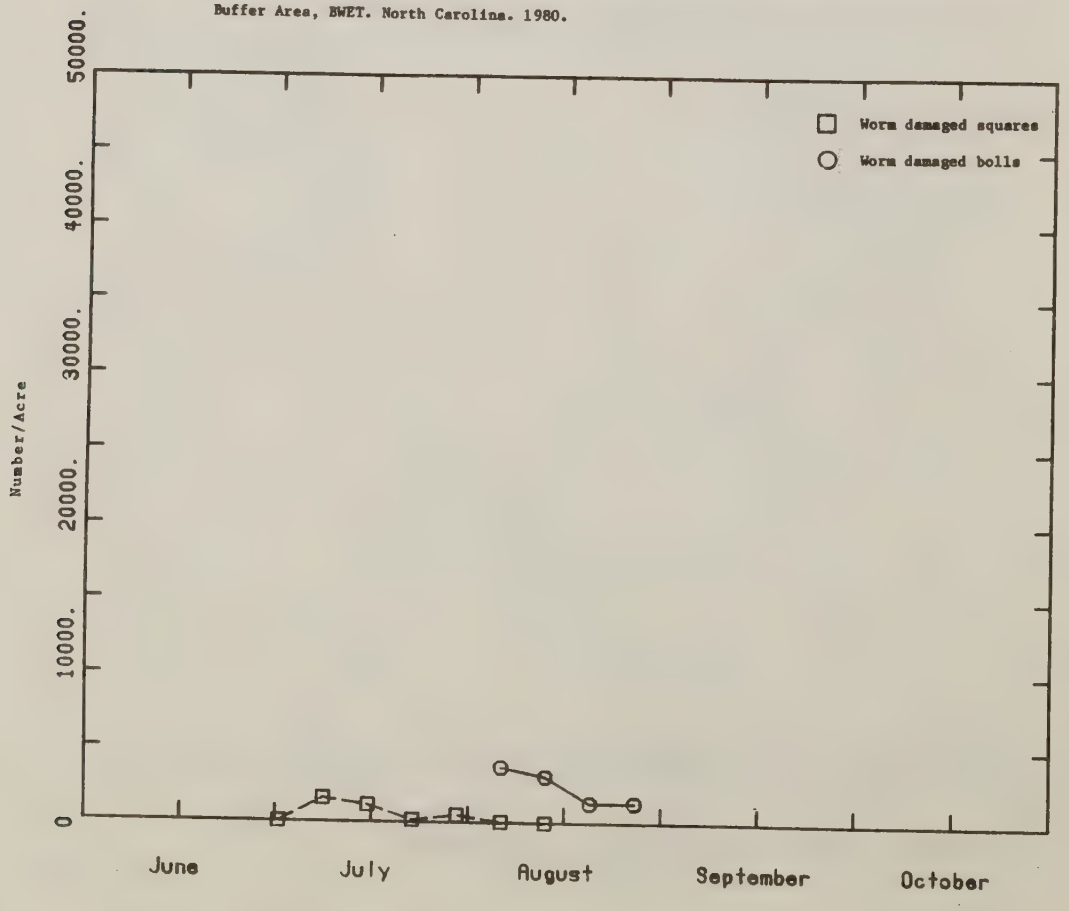


Figure 39. Estimates of squaring, boll set, boll opening, rainfall, use of nitrogen, and yield in intensively sampled fields in Chowan County, EWET. North Carolina. 1980.

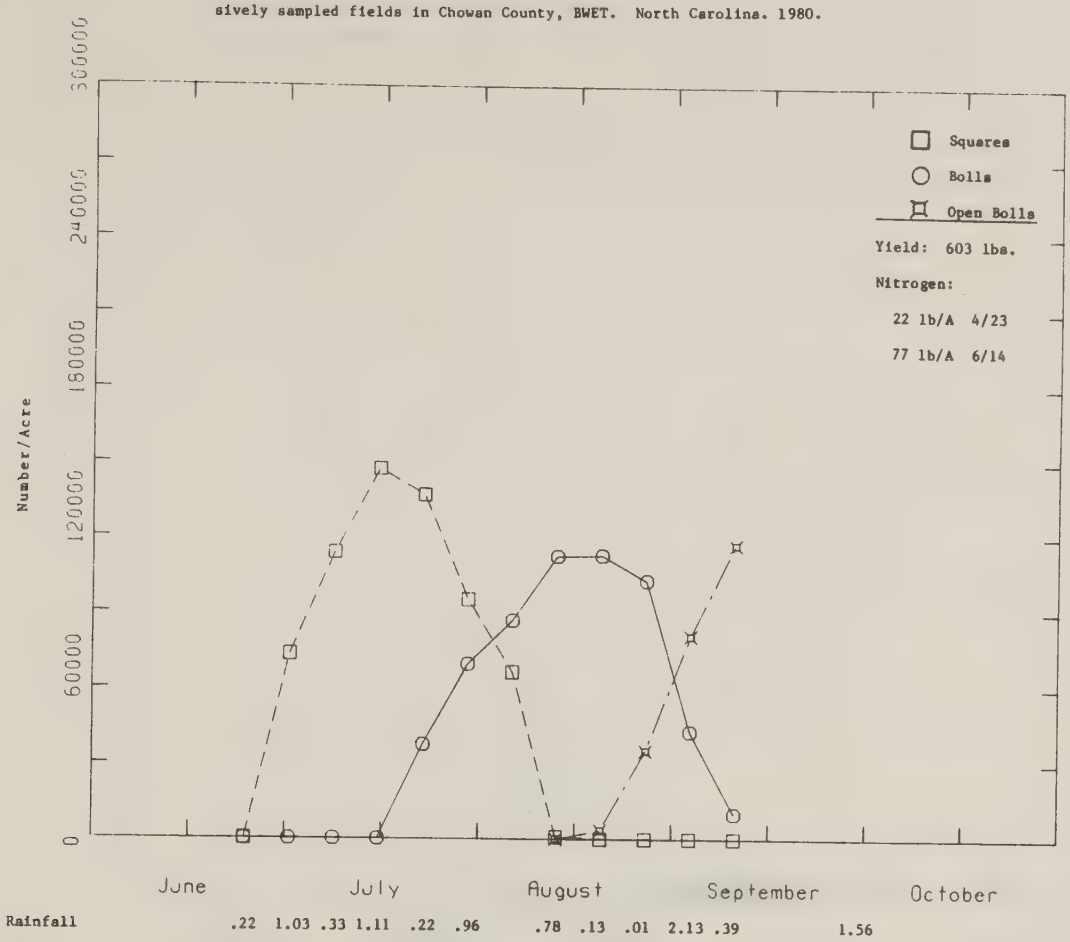
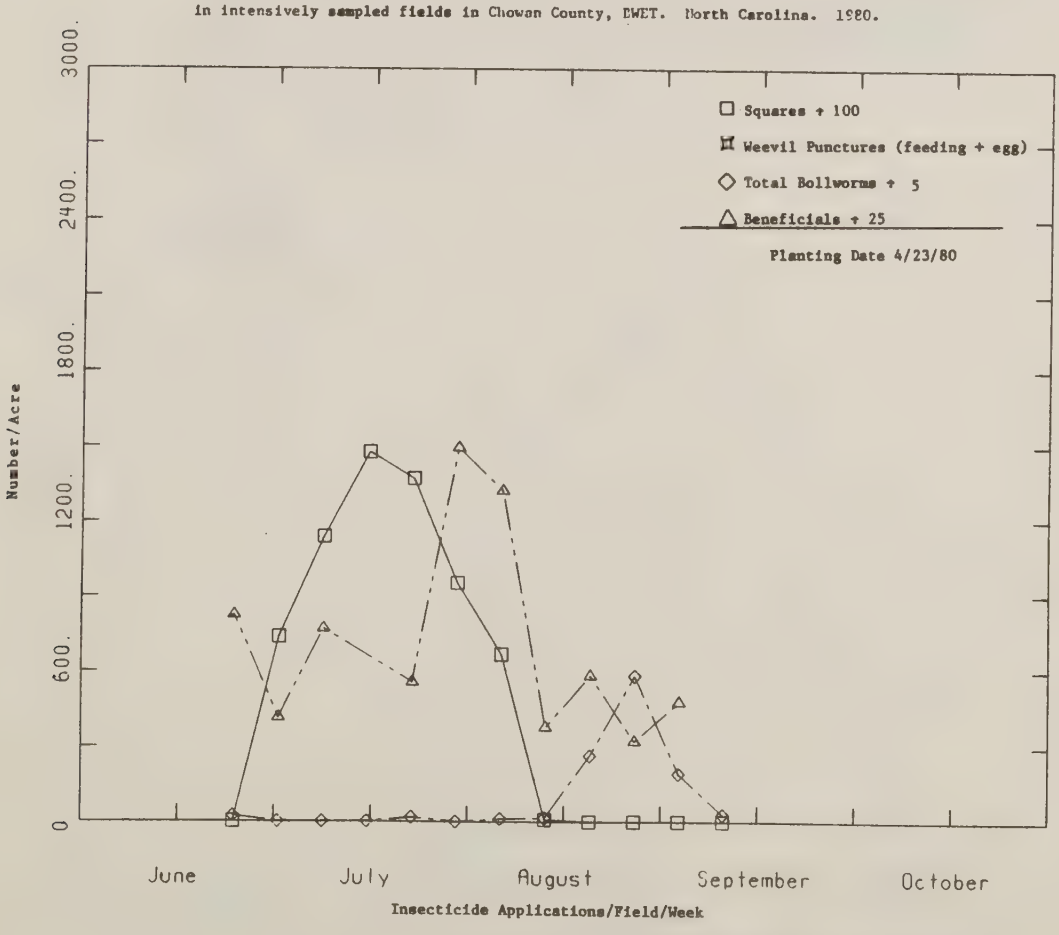


Figure 40. Estimated no. of squares, boll weevil punctures (feeding and oviposition), total bollworms, beneficial arthropods (except predacious thrips) per acre, and no. of insecticide treatments in intensively sampled fields in Chowan County, EWET. North Carolina. 1980.



Insecticides were not required for the control of cotton insects.

Figure 41. Estimated no. of bollworm damaged bolls and squares in intensively sampled fields, Chowan County, BWET. North Carolina. 1980.

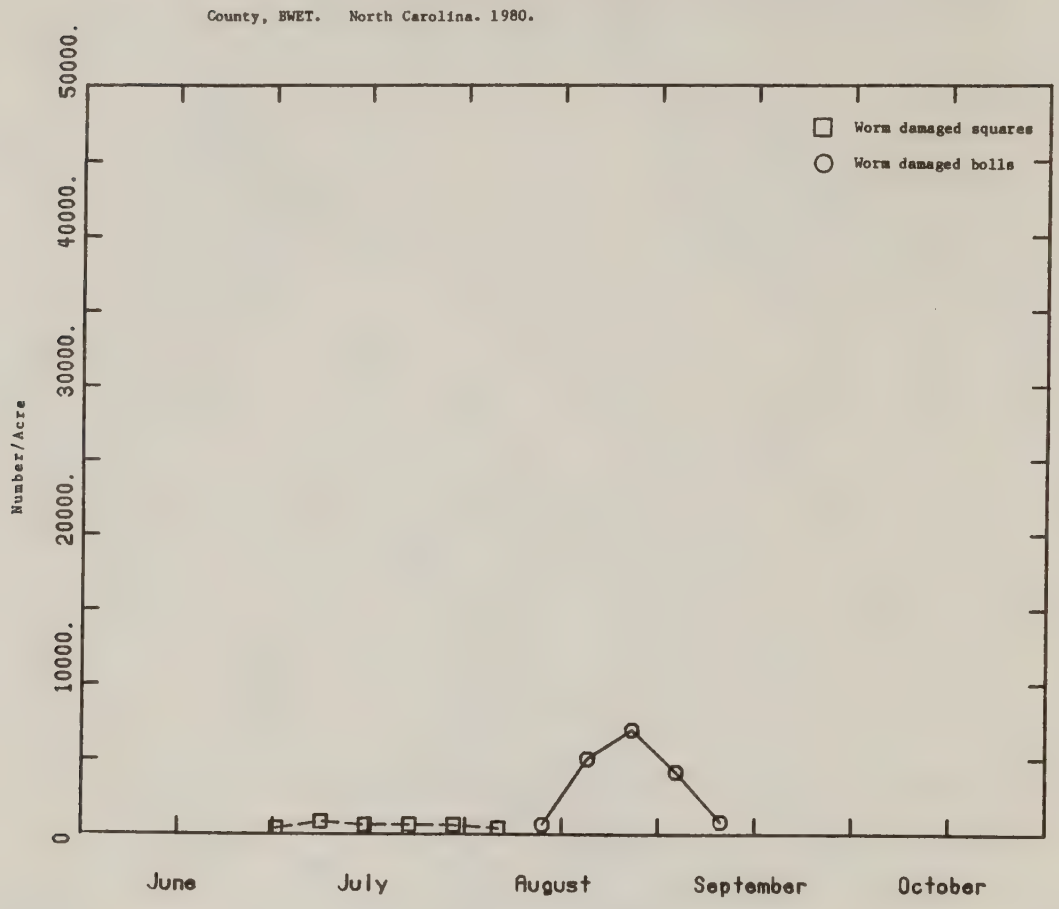
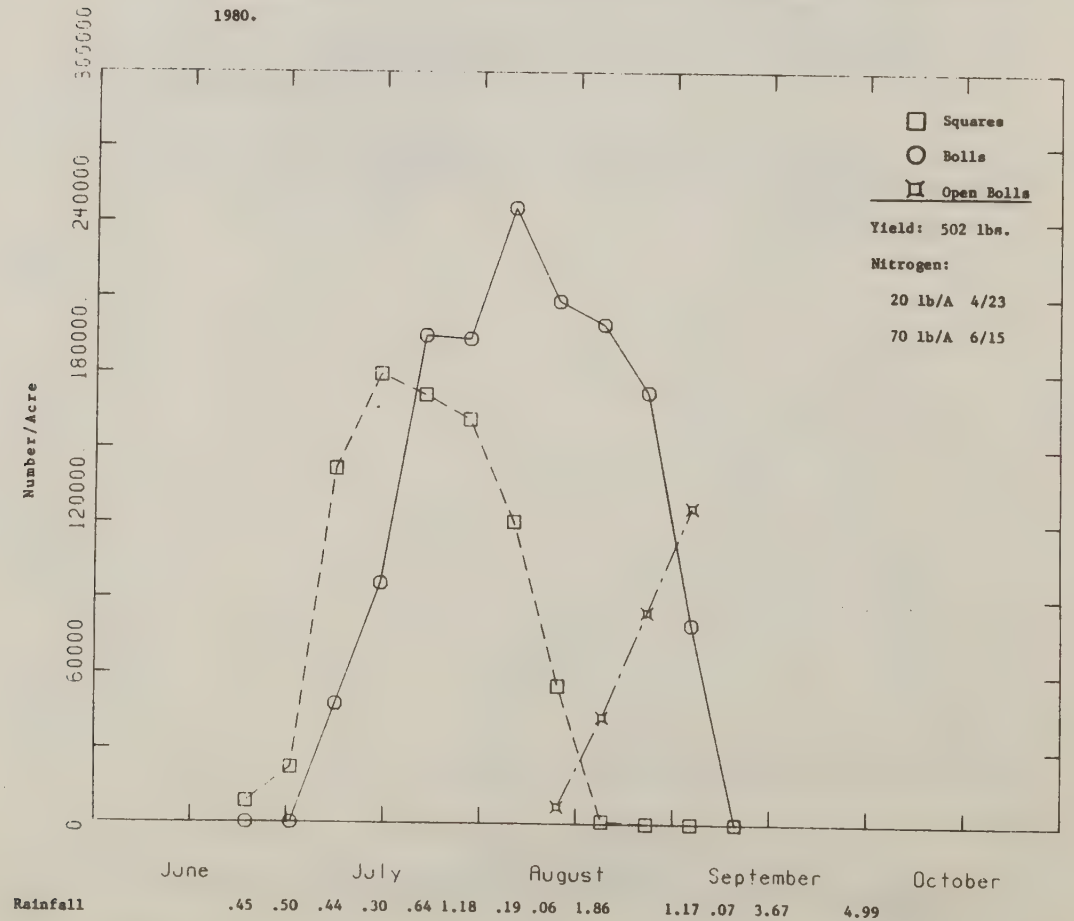
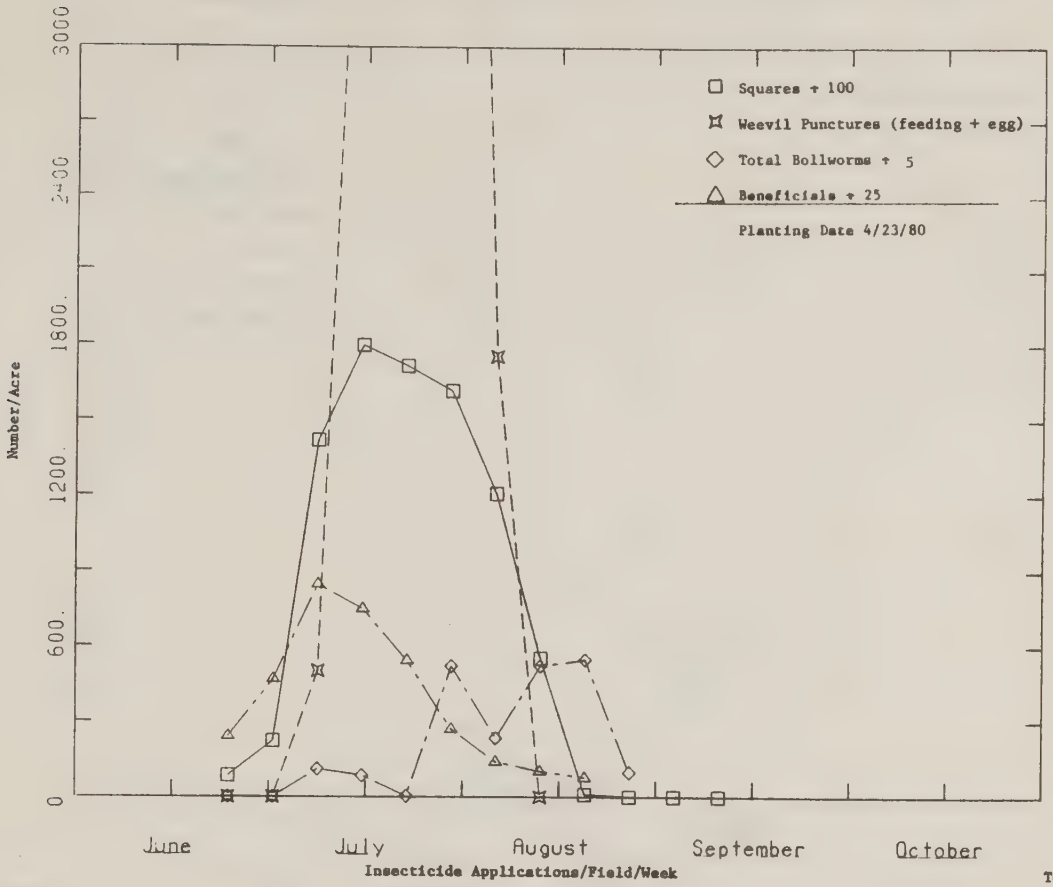


Figure 42. Estimates of squaring, boll set, boll opening, rainfall, use of nitrogen, and yield in intensively sampled fields in Scotland-Robeson counties outside BWET area. North Carolina. 1980.



beneficial arthropods (except predacious thrips) per acre, and no. of insecticide treatments in intensively sampled fields in Scotland-Robeson counties outside BWET area. North Carolina 1980.



	Insecticide Applications/Field/Week										Total
Pyrethroid	.50	.25	.25	1.13	1.50	1.13	1.00	.50	.25		6.51
Chlordimeform				.13	.25	.13					.51
Organophosphates (± toxaphene)	.25		.25				.25	.25	.50	.50	2.00
Methomyl									.25	.25	.50
											9.52

Figure 44. Estimated no. of bollworm damaged bolls and squares in intensively sampled fields in Scotland-Robeson counties outside BWET area. North Carolina. 1980.

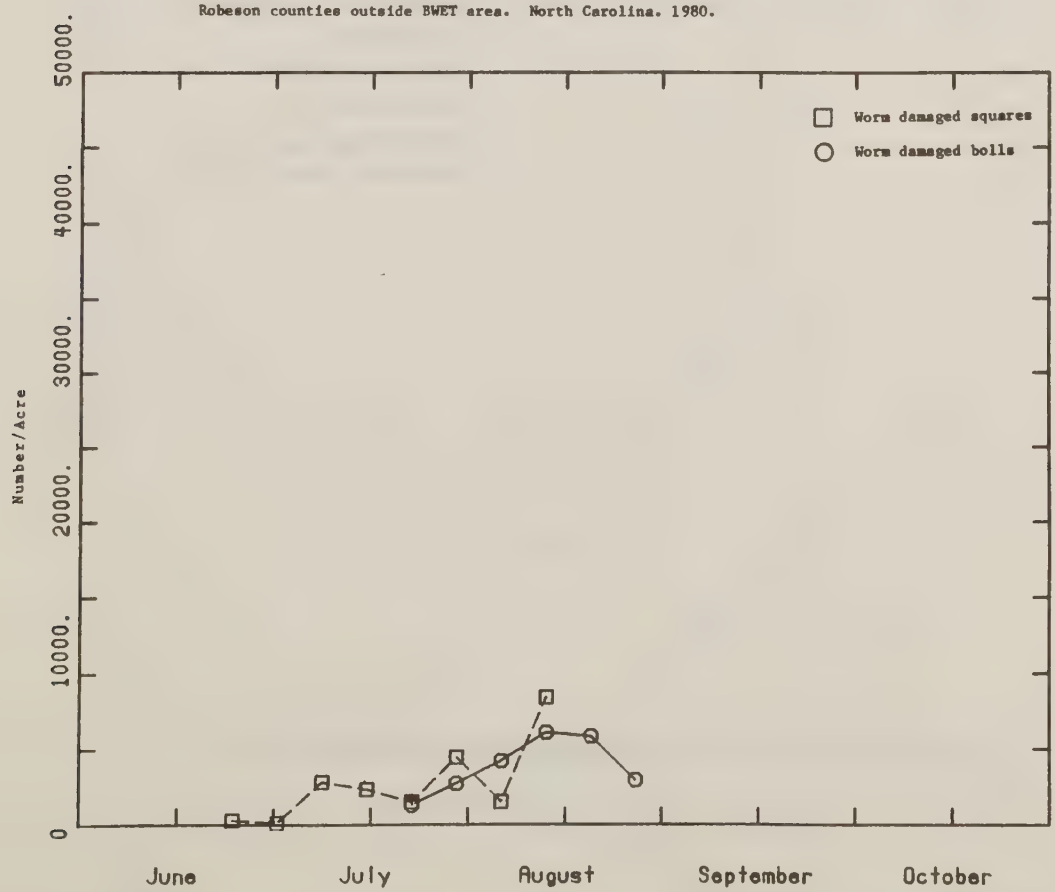
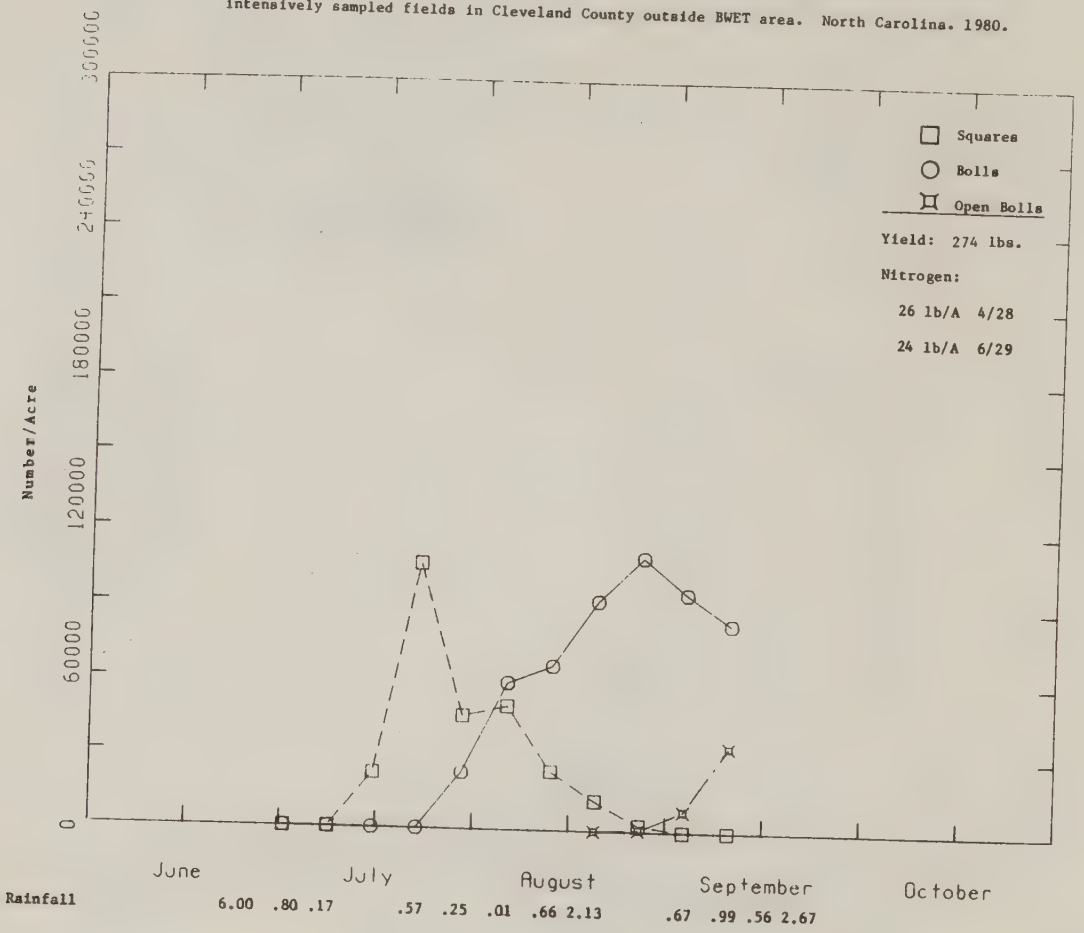
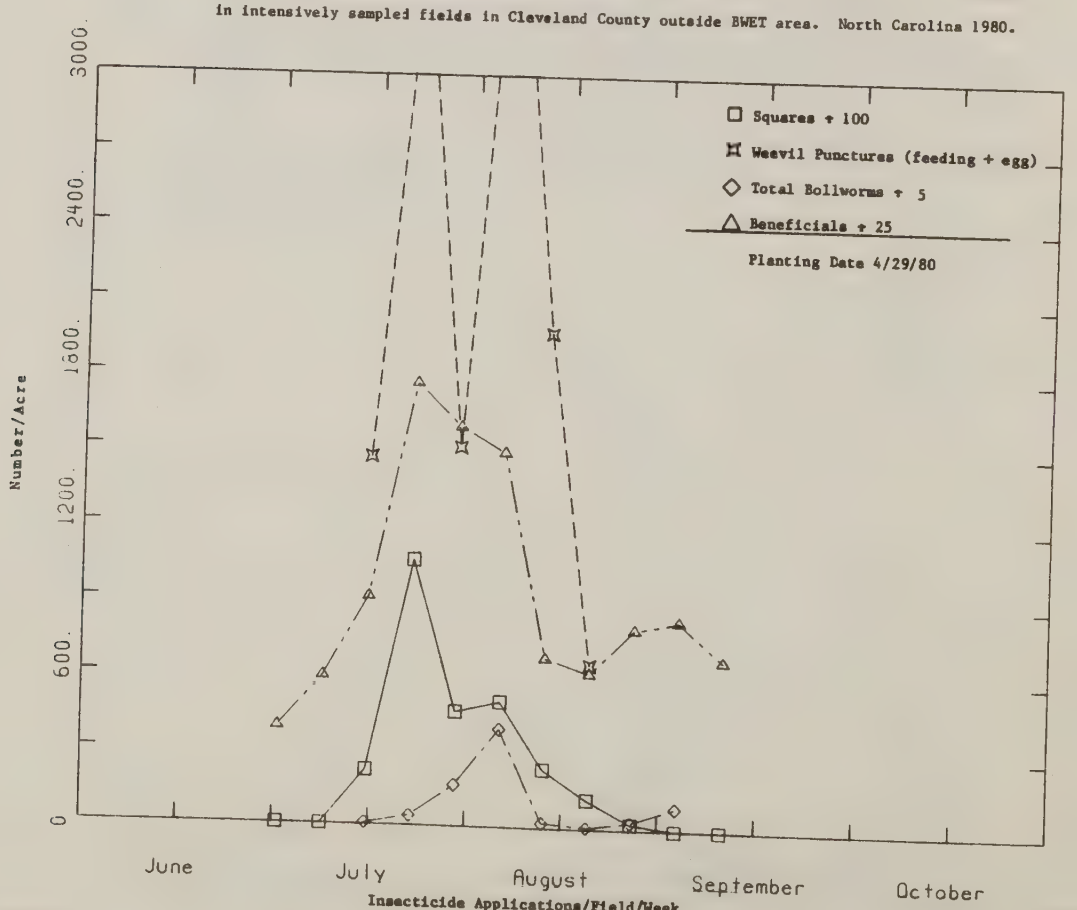


Figure 45. Estimates of squaring, boll set, boll opening, rainfall, use of nitrogen, and yield in intensively sampled fields in Cleveland County outside BWET area. North Carolina. 1980.



Rainfall 6.00 .80 .17 .57 .25 .01 .66 2.13 .67 .99 .56 2.67

Figure 46. Estimated no. of squares, boll weevil punctures (feeding and oviposition), total bollworms, beneficial arthropods (except predacious thrips) per acre, and no. of insecticide treatments in intensively sampled fields in Cleveland County outside BWET area. North Carolina 1980.



	Insecticide Applications/Field/Week							Total
Pyrethroid				.08	.25	.13	.13	.59
Chlordimeform					.13	.13	.13	.39
Organophosphates (± toxaphene)	.25	.25	.25	.67	.13			2.05
						.50		3.03

Figure 47. Estimated no. of bollworm damaged bolls and squares in intensively sampled fields in Cleveland County outside BWET area. North Carolina. 1980.

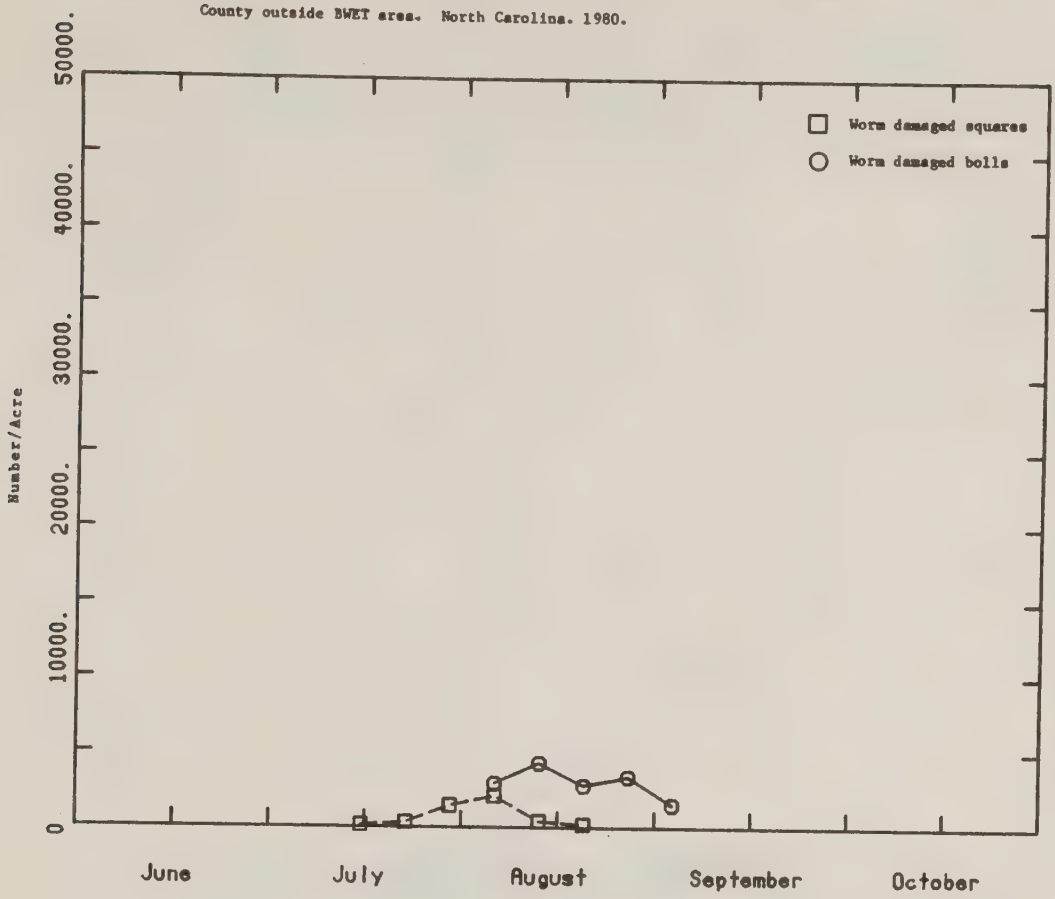


Figure 48. Estimated no. of boll weevil punctures (feeding and oviposition) in 1977 fields and in 1978, 1979 and 1980 intensive fields in Evaluation Area, BWET. North Carolina.

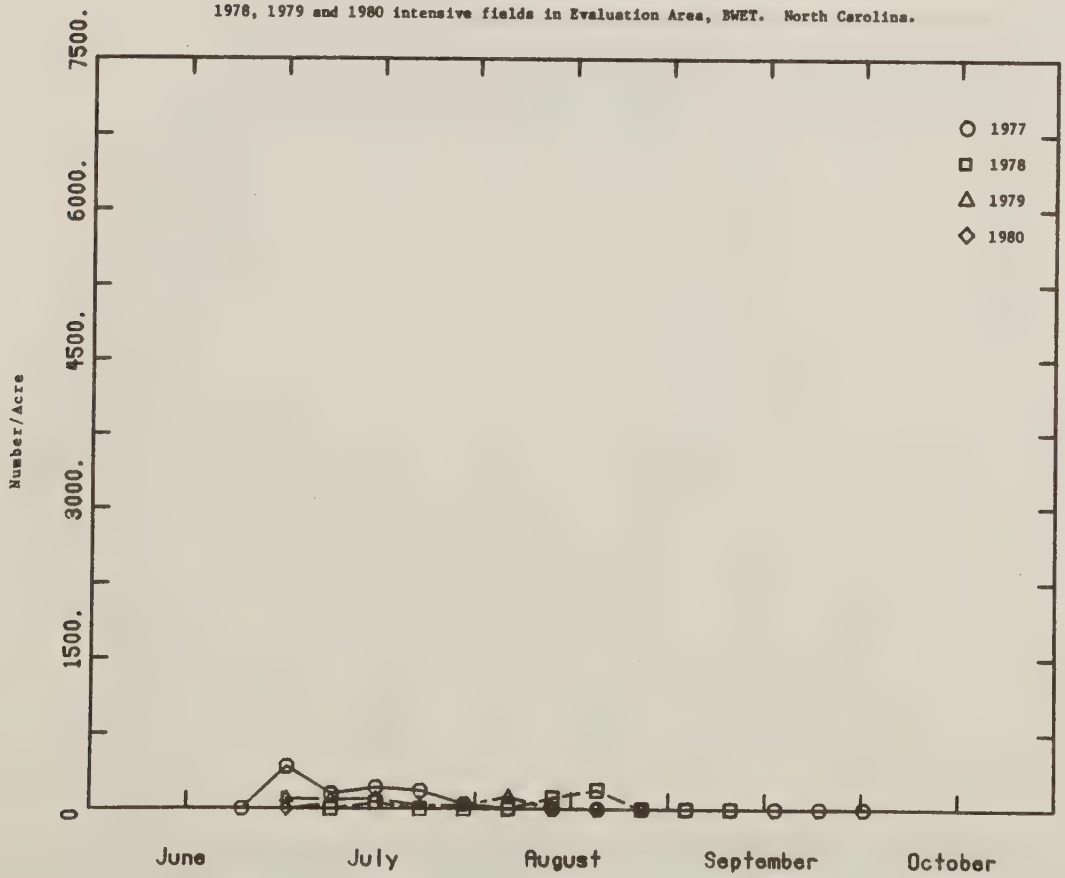


Figure 49. Estimated no. of boll weevil punctures (feeding and oviposition) in 1978, 1979 and 1980 intensive fields in Buffer Area, BWET. North Carolina.

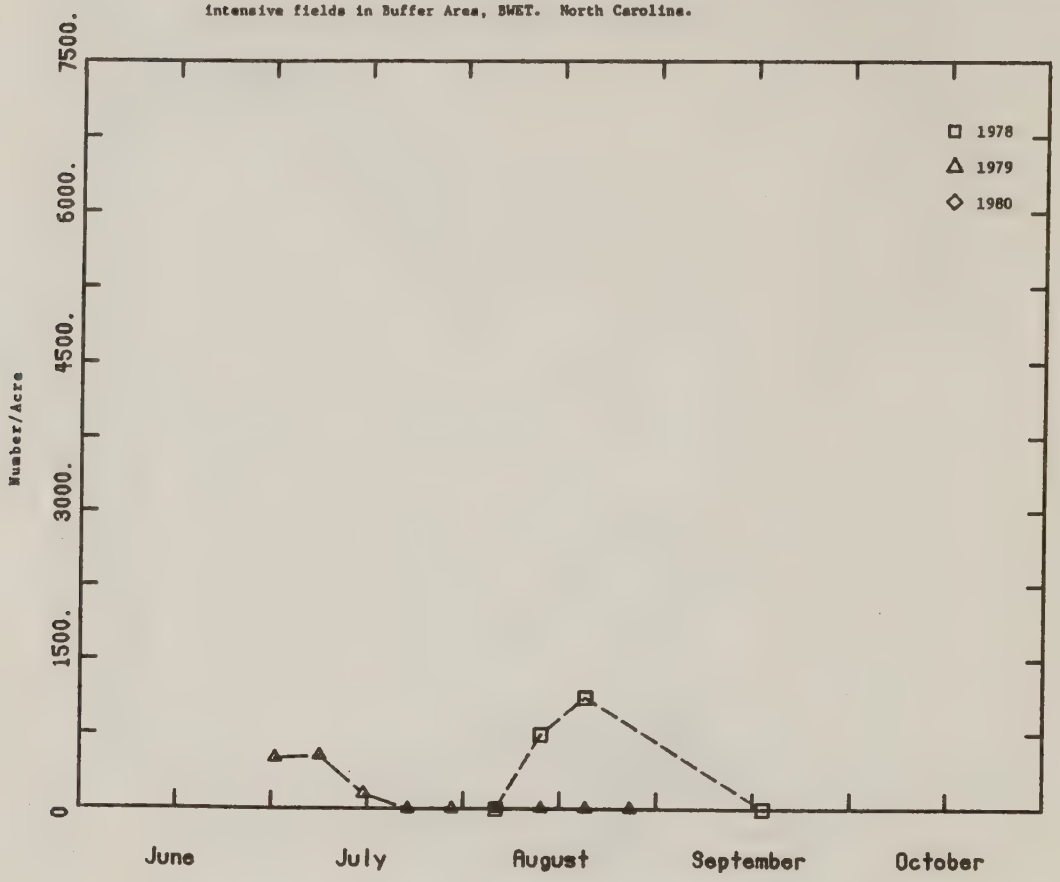


Figure 50. Estimated no. of boll weevil punctures (feeding and oviposition) in 1977 fields and in 1978, 1979 and 1980 intensive fields in Chowan County, BWET. North Carolina.

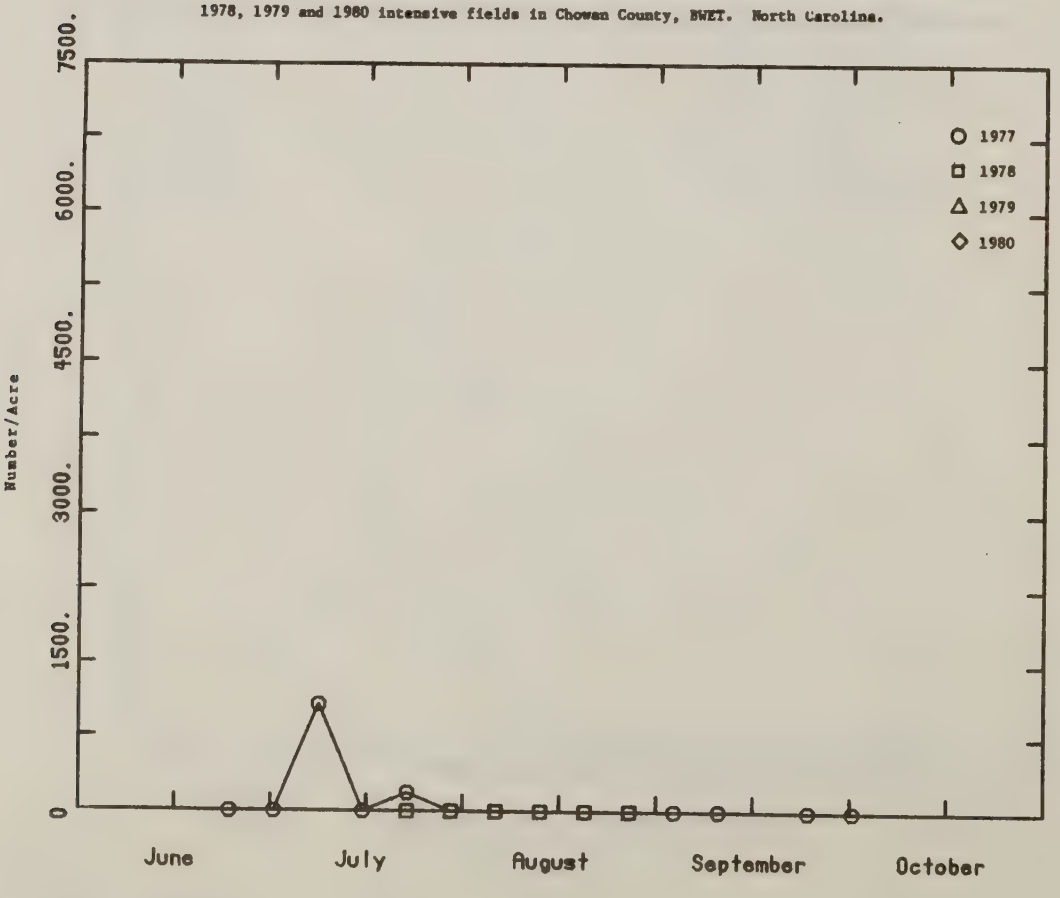


Figure 51. Estimated no. of boll weevil punctures (feeding and oviposition) in 1977 fields and in 1978, 1979 and 1980 intensive fields in Scotland-Robeson counties outside BWET area. North Carolina.

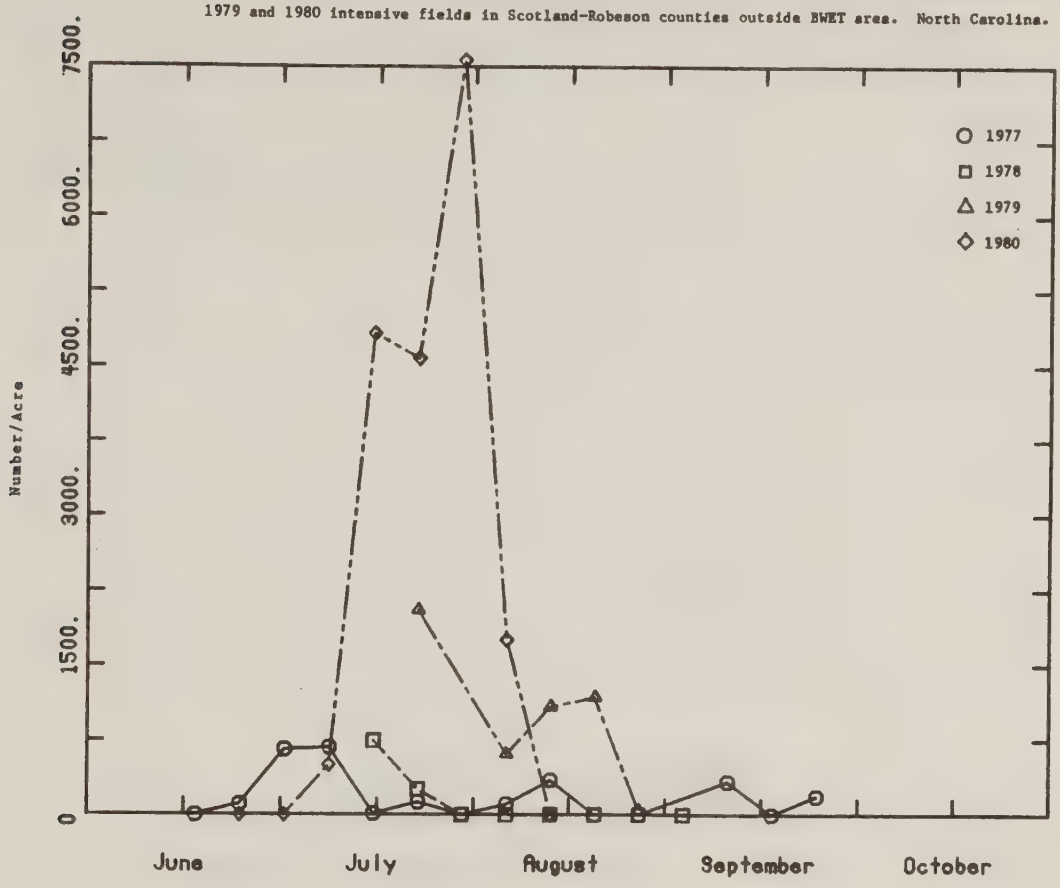


Figure 52. Estimated no. of boll weevil punctures (feeding and oviposition) in 1977 fields and in 1978, 1979 and 1980 intensive fields in Cleveland County outside BWET area. North Carolina.

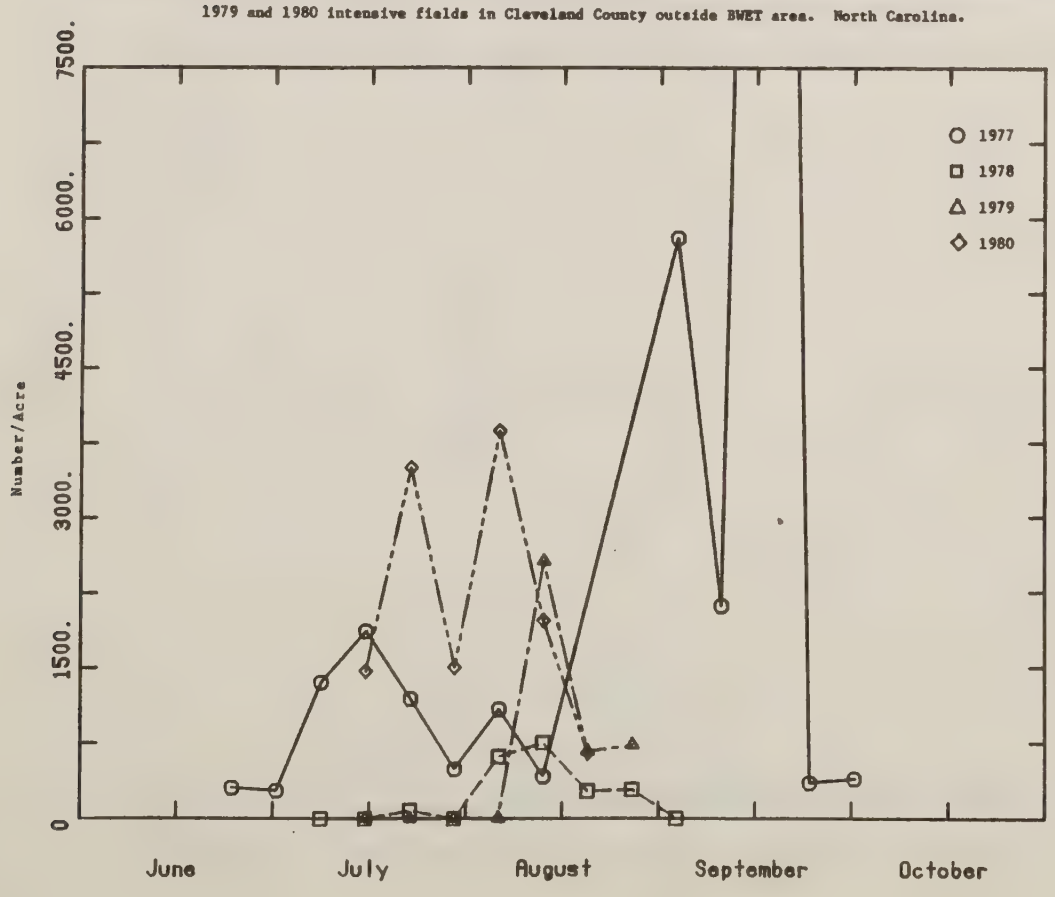


Figure 53. Estimated no. of bollworm larvae in terminals in 1977 fields and 1978, 1979 and 1980 intensive fields in Evaluation Area, BWET. North Carolina.

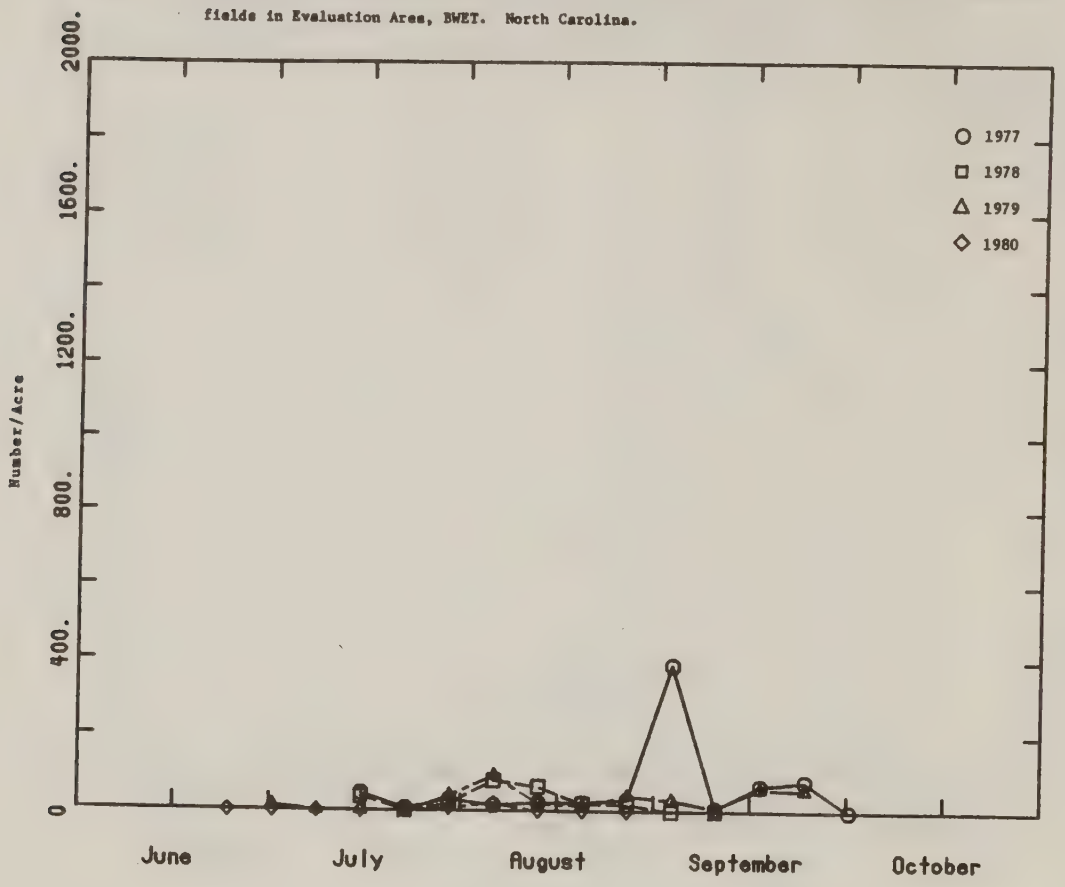


Figure 54. Estimated no. of bollworm larvae in terminals in intensively sampled fields in Buffer Area, BWET. North Carolina. 1978, 1979 and 1980.

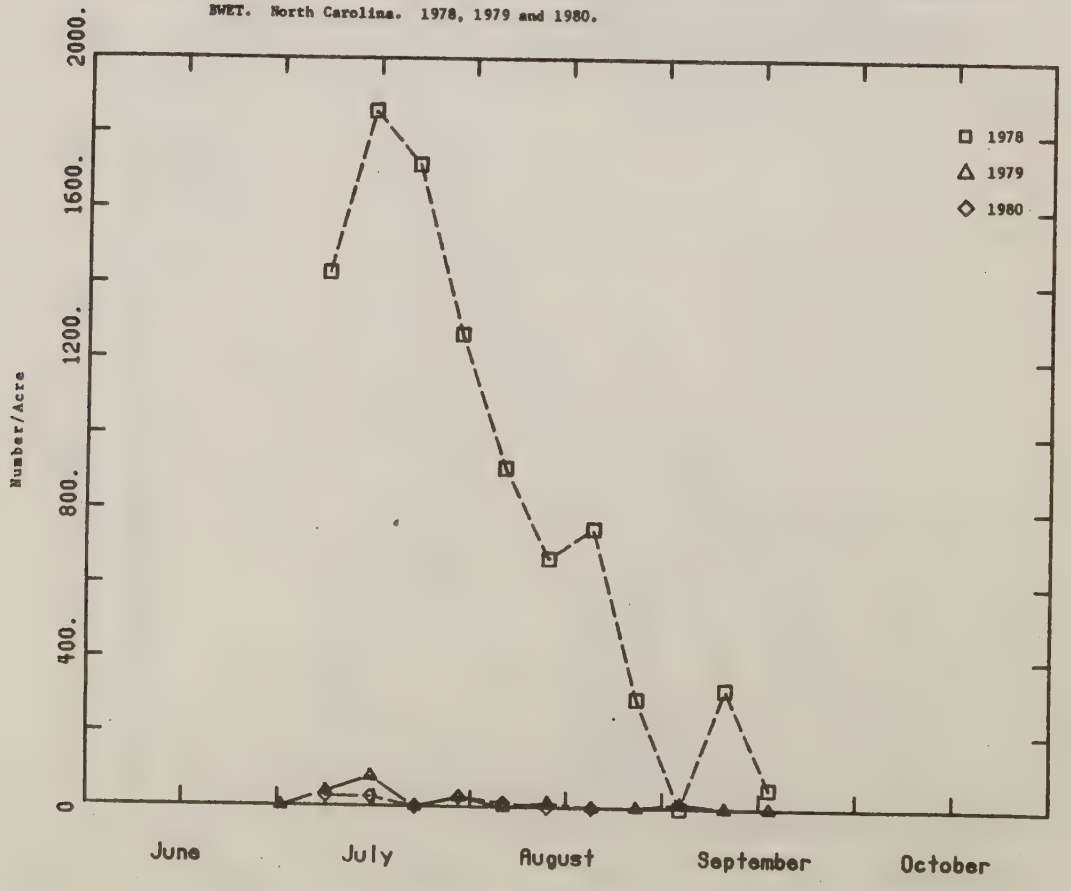


Figure 55. Estimated no. of bollworm larvae in terminals in 1977 fields and 1978, 1979 and 1980 intensive fields in Chowan County, BWET. North Carolina.

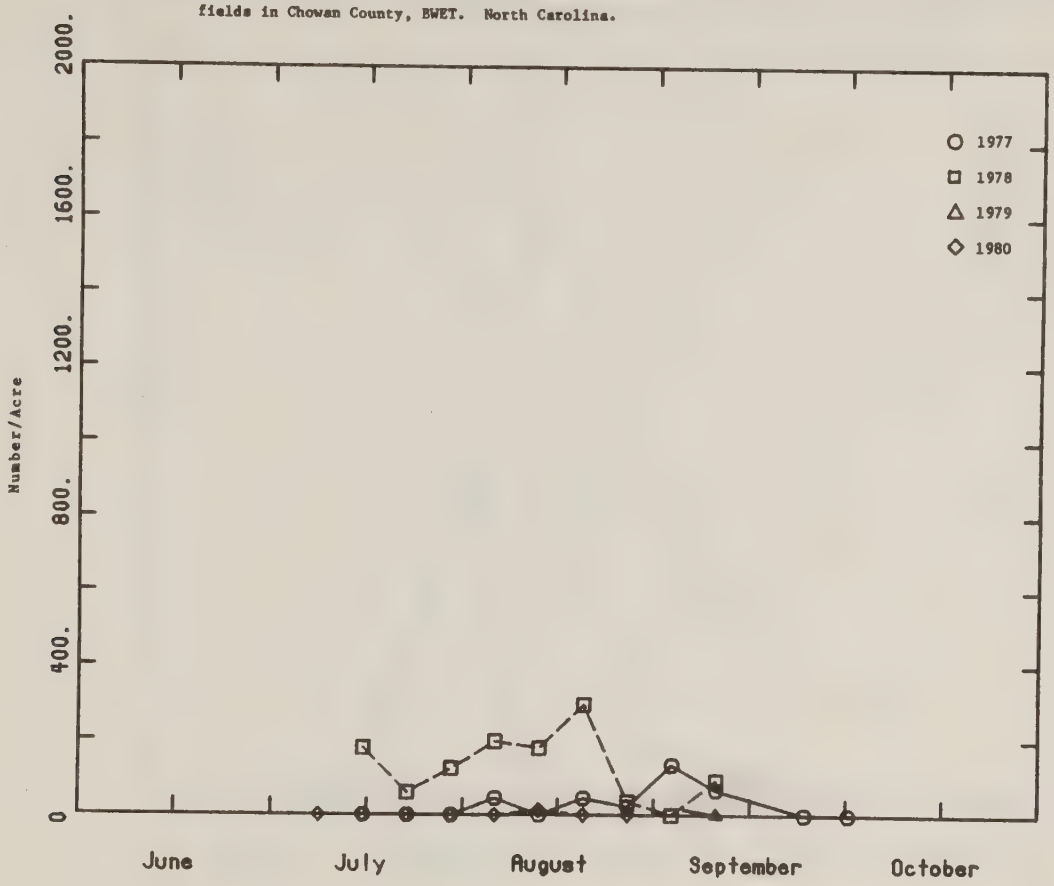


Figure 56. Estimated no. of bollworm larvae in terminals in 1977 fields and 1978, 1979 and 1980 intensive fields in Scotland-Robeson counties outside BWET area. North Carolina.

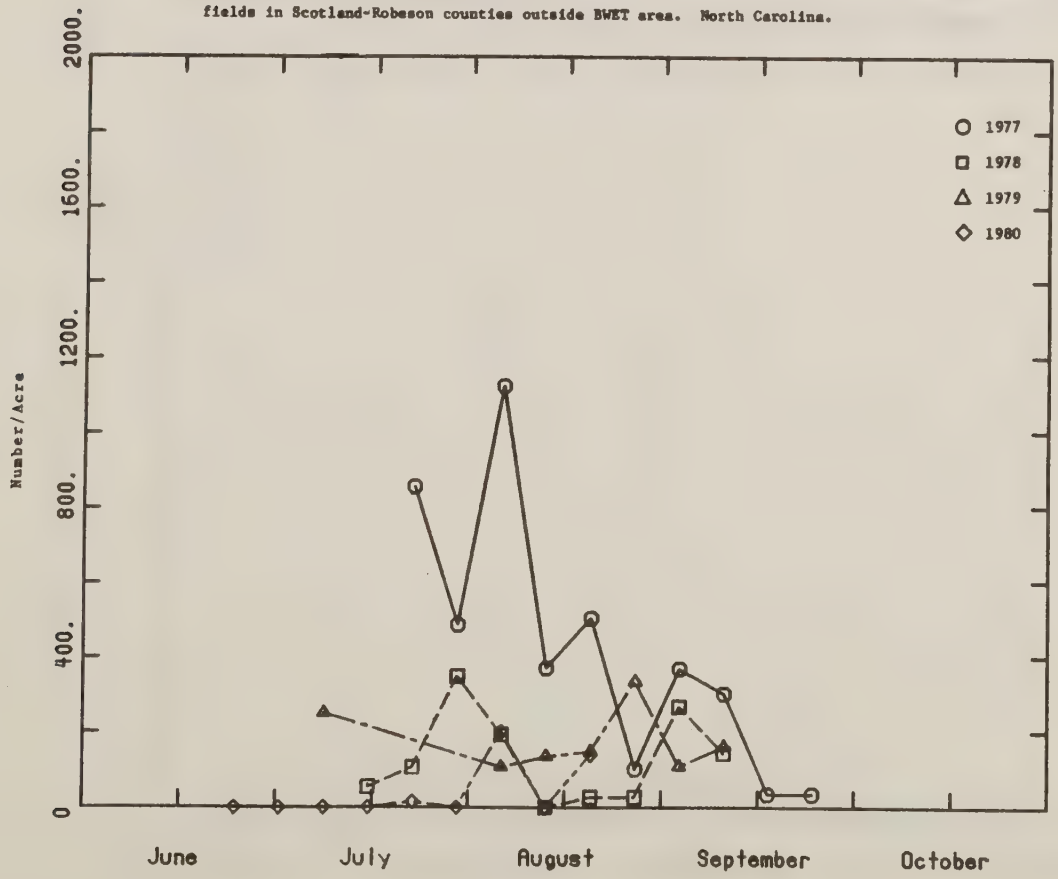


Figure 57. Estimated no. of bollworm larvae in terminals in 1977 fields and 1978, 1979 and 1980 intensive fields in Cleveland County outside BWET area. North Carolina.

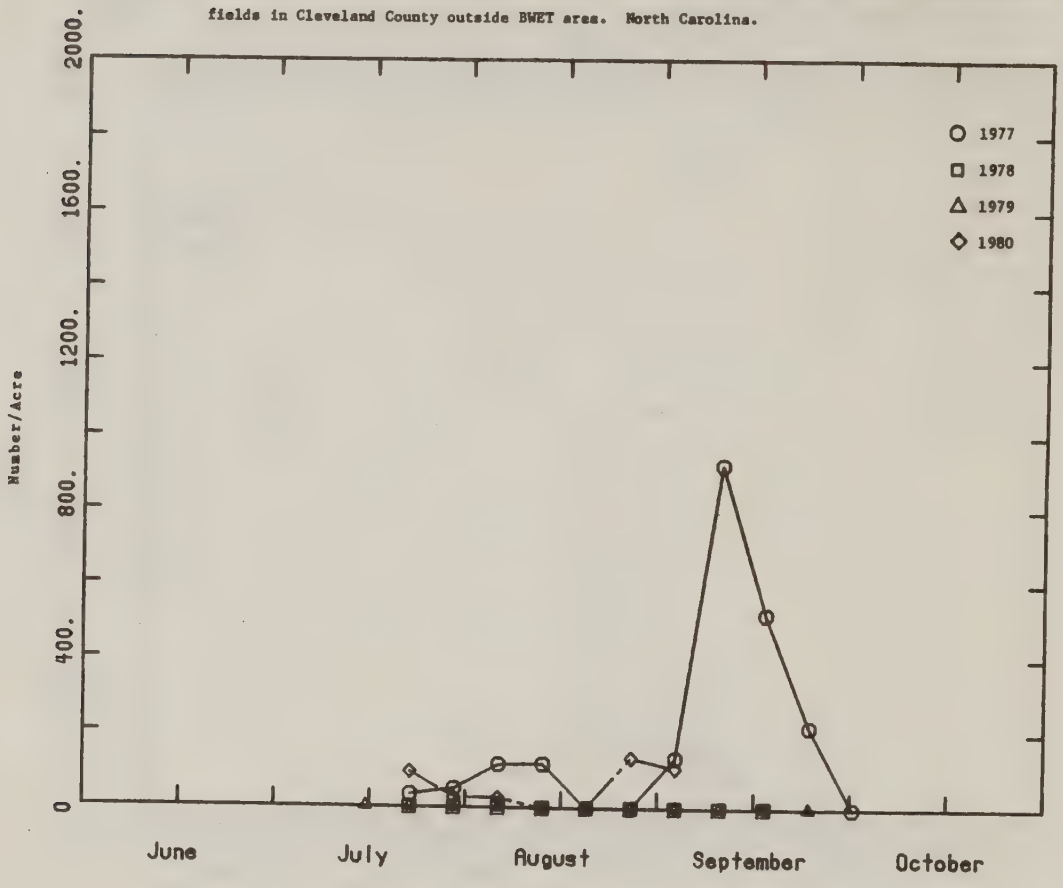


Figure 58. Estimated no. of bollworm larvae in squares in 1977 fields and 1978, 1979 and 1980 intensive fields in Evaluation Area, BWET. North Carolina.

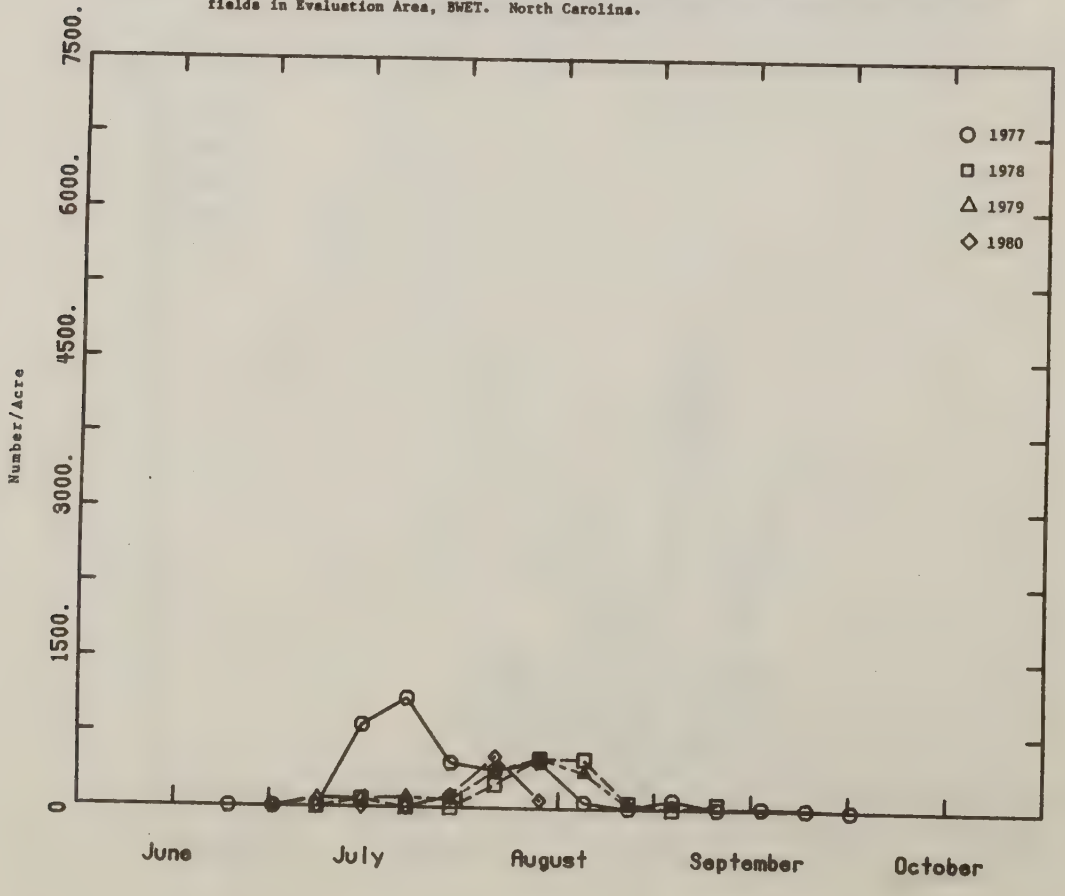


Figure 59. Estimated no. of bollworm larvae in squares in intensively sampled fields in Buffer Area, BWET. North Carolina 1978, 1979 and 1980.

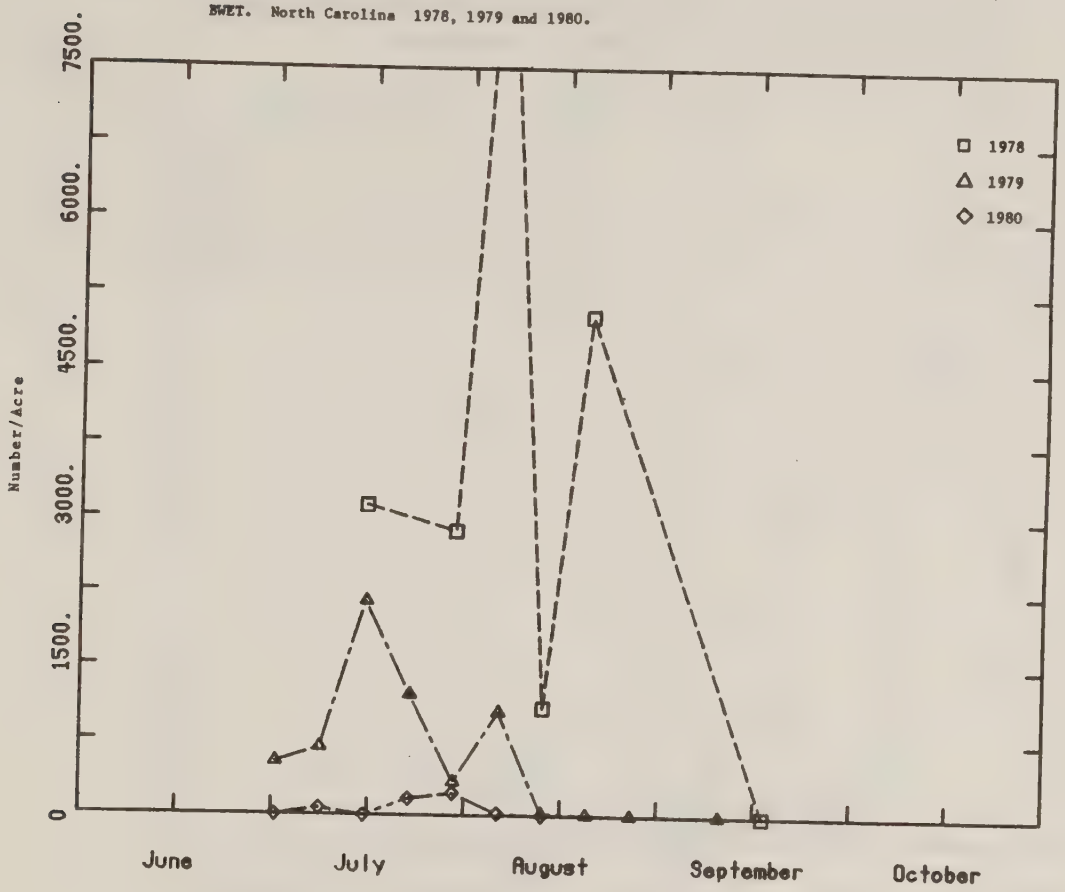


Figure 60. Estimated no. of bollworm larvae in squares in 1977 fields and 1978, 1979 and 1980 intensive fields in Chowan County, BWET. North Carolina.

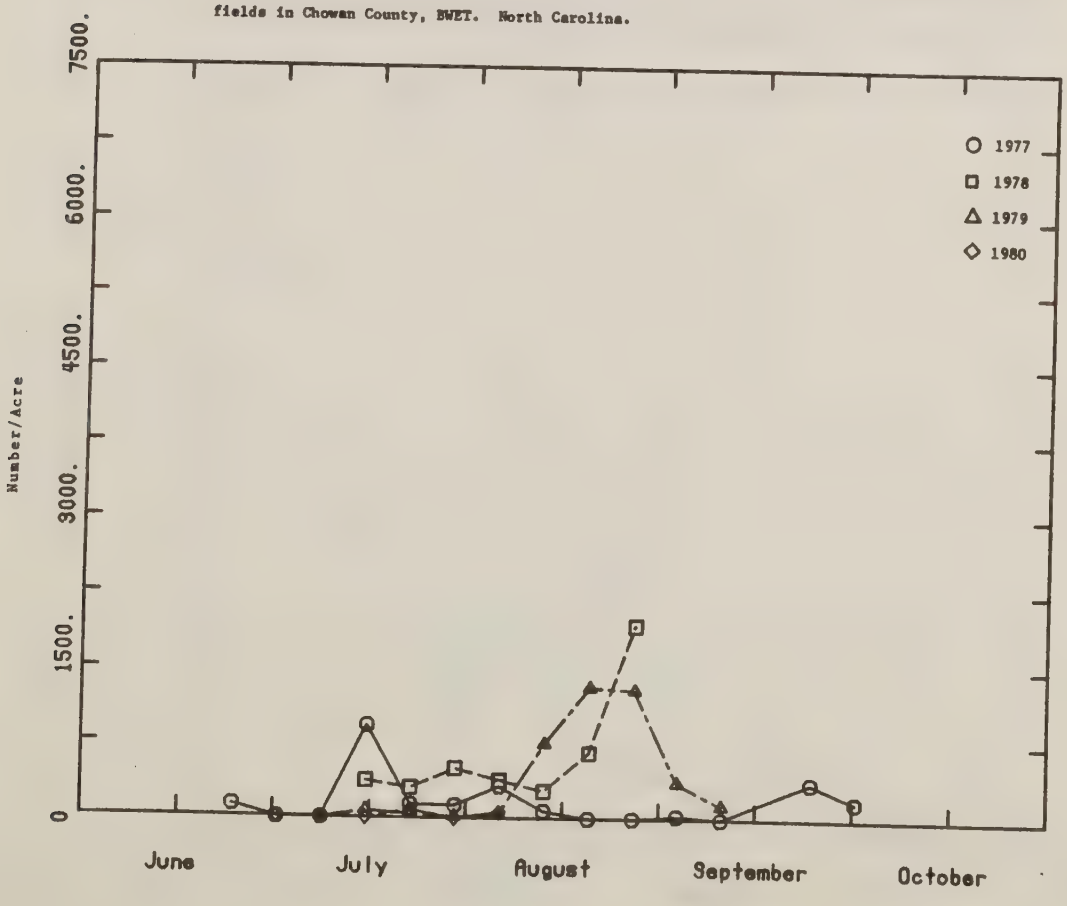


Figure 61. Estimated no. of bollworm larvae in squares in 1977 fields and 1978, 1979 and 1980 intensive fields in Scotland-Robeson counties outside BWET area. North Carolina.

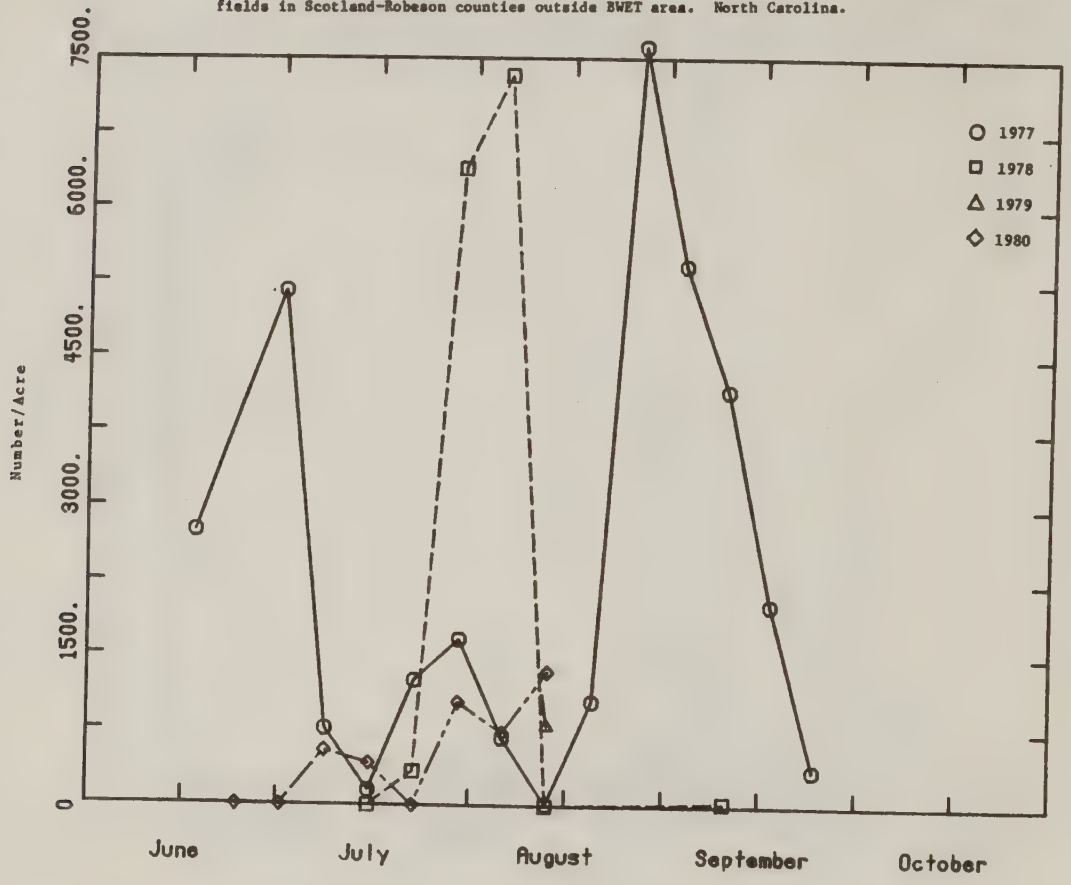


Figure 62. Estimated no. of bollworm larvae in squares in 1977 fields and 1978, 1979, and 1980 intensive fields in Cleveland County outside BWET area. North Carolina.

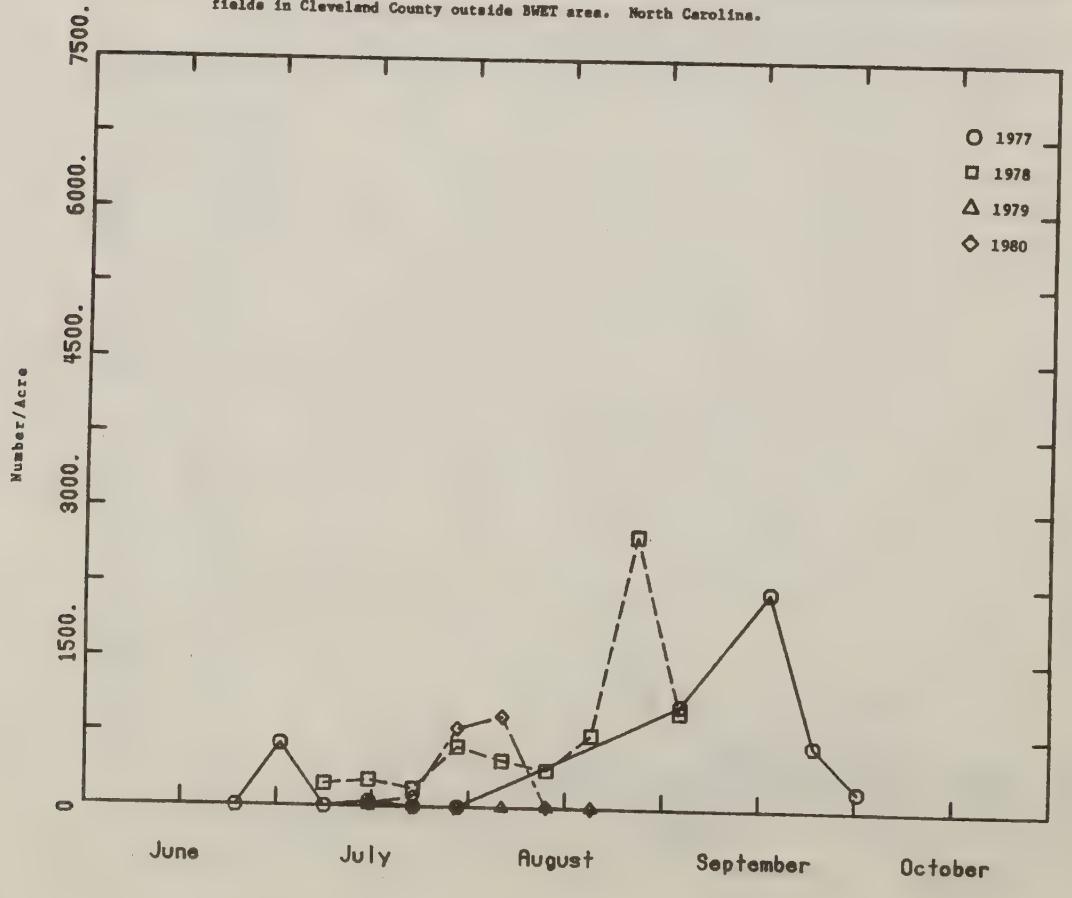


Figure 63. Estimated no. of bollworm damaged squares per acre in 1977 fields and 1978, 1979 and 1980 intensive fields in the Evaluation Area, BWET.

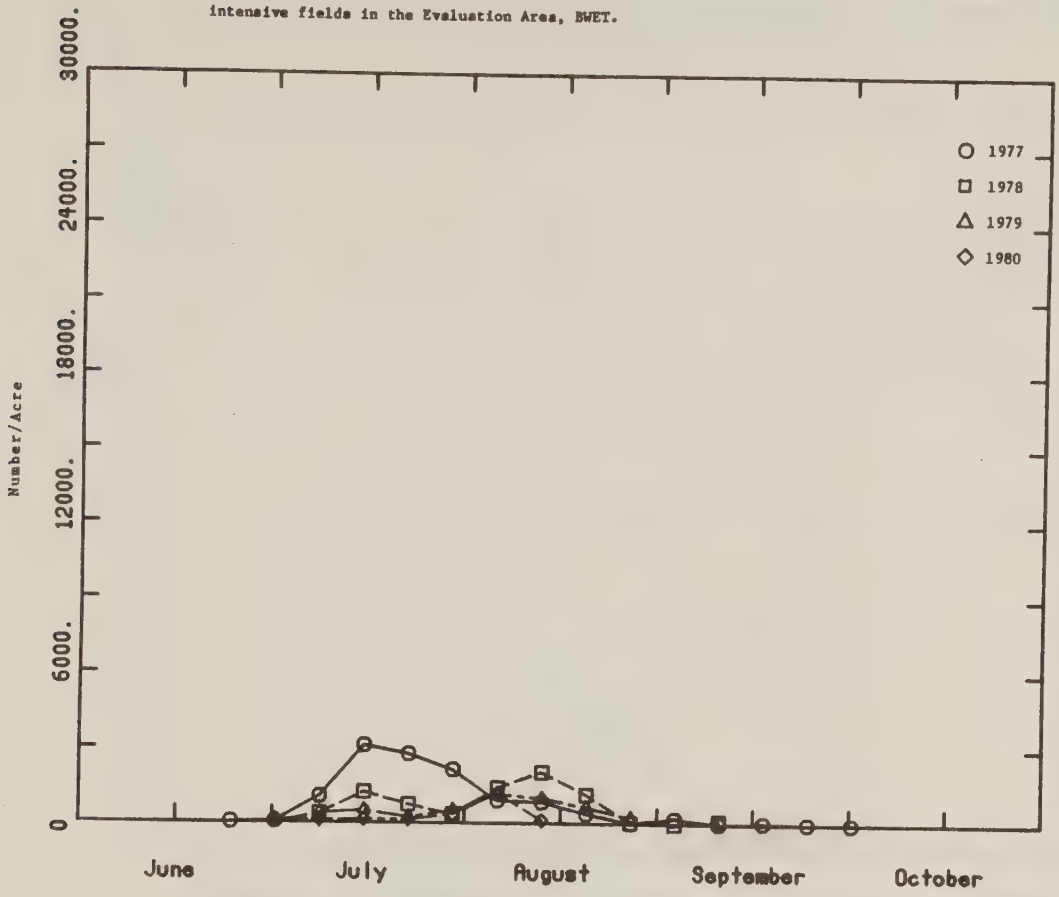


Figure 64. Estimated no. of bollworm damaged squares per acre in intensively sampled fields in the Buffer Area, BWET. North Carolina. 1978, 1979 and 1980.

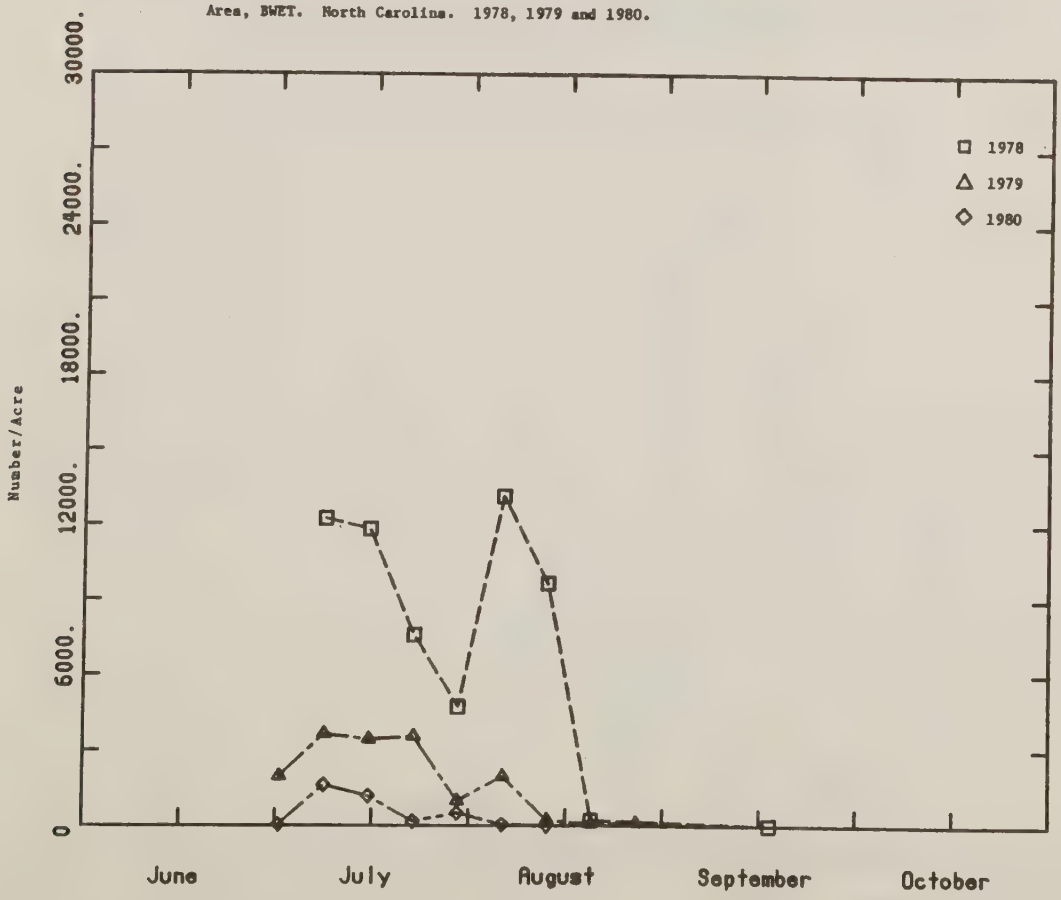


Figure 65. Estimated no. of bollworm damaged squares per acre in 1977 fields and in 1978, 1979 and 1980 intensively sampled fields in Chowan County, BWET. North Carolina.

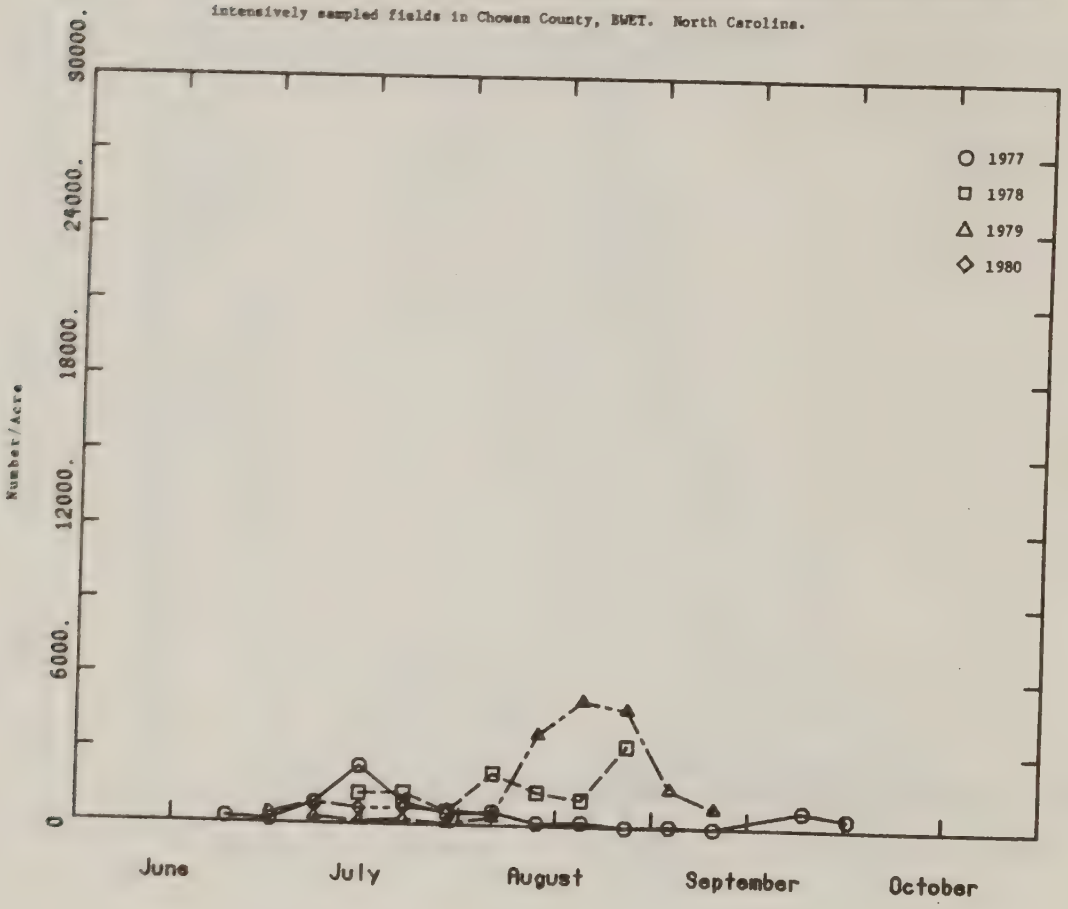


Figure 66. Estimated no. of bollworm damaged squares per acre in 1977 fields and in 1978, 1979 and 1980 intensively sampled fields in Scotland-Robeson counties outside BWET area. North Carolina.

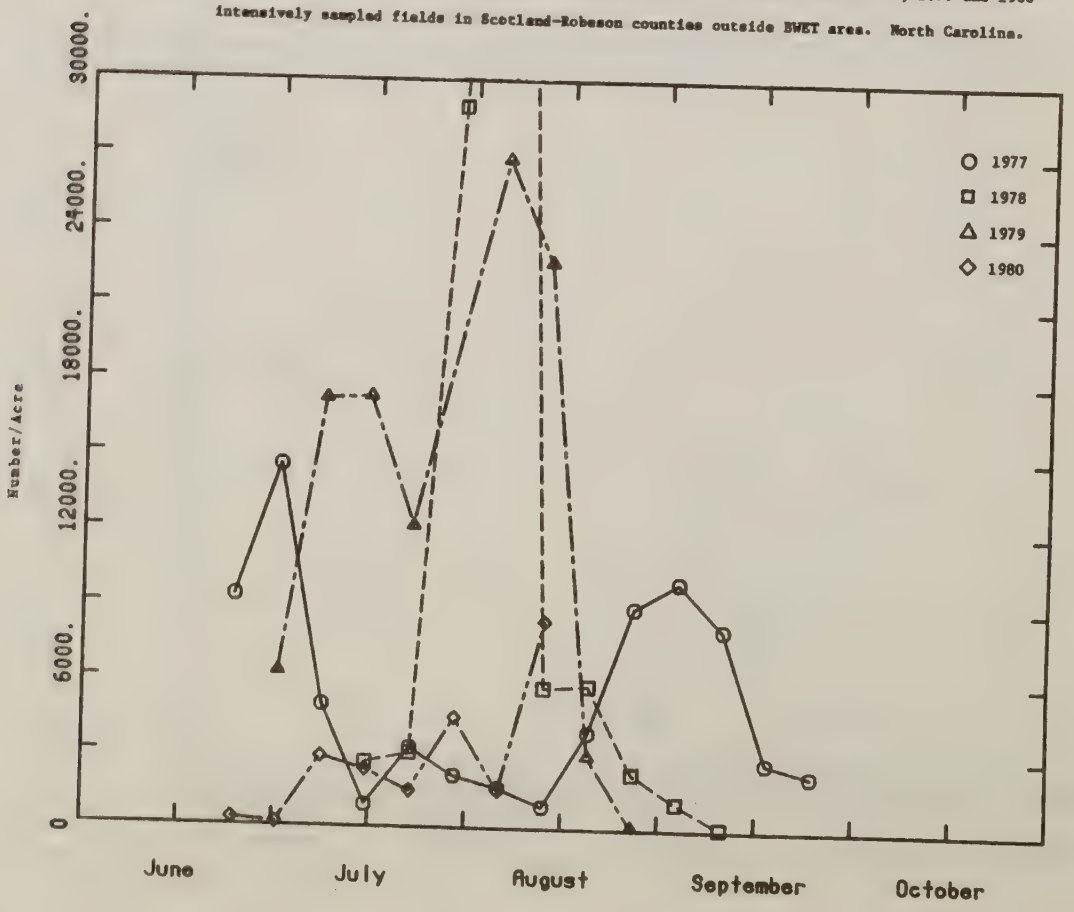


Figure 67. Estimated no. of bollworm damaged squares per acre in 1977 fields and in 1978, 1979, and 1980 intensively sampled fields in Cleveland County outside BWET area. North Carolina.

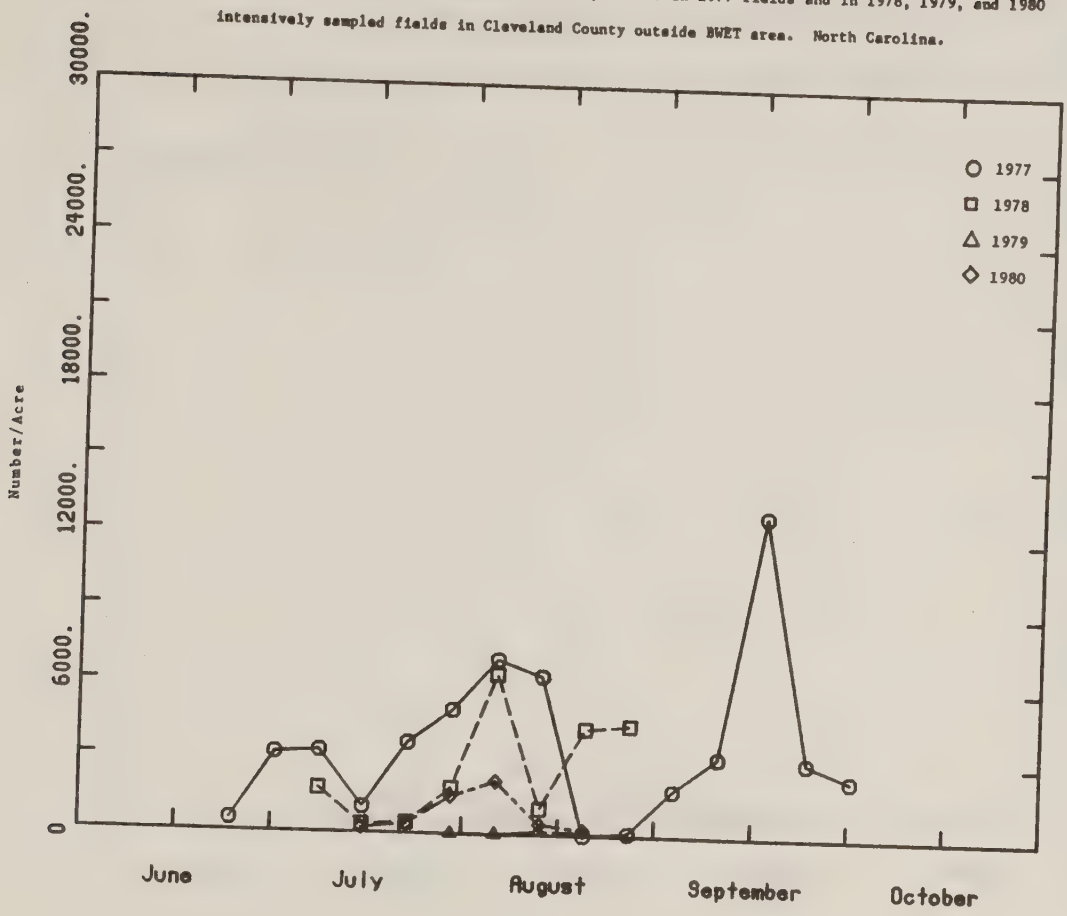


Figure 68. Estimated no. of bollworm larvae and no. of bollworm damaged bolls per acre in sampled fields in the Evaluation Area, BWET. North Carolina. 1977.

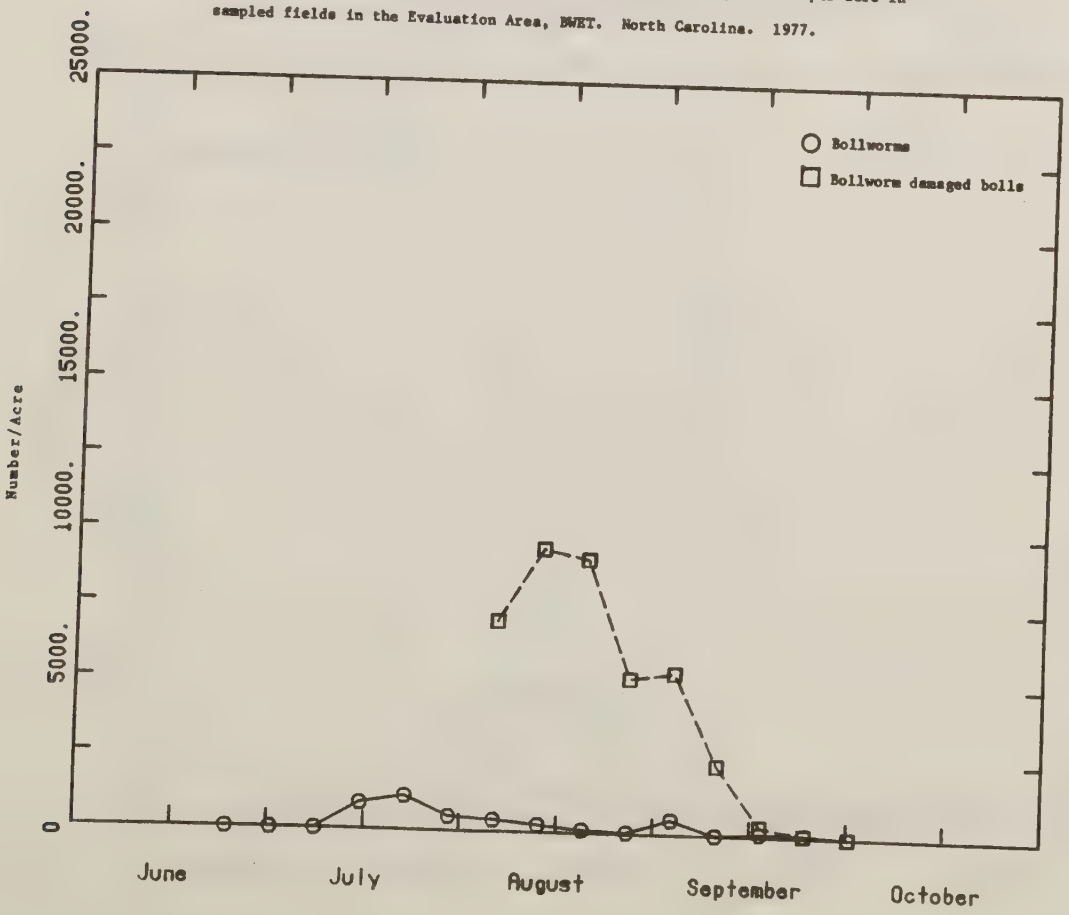


Figure 69. Estimated no. of bollworm larvae and no. of bollworm damaged bolls per acre in sampled fields in the Evaluation Area, BWET. North Carolina. 1978.

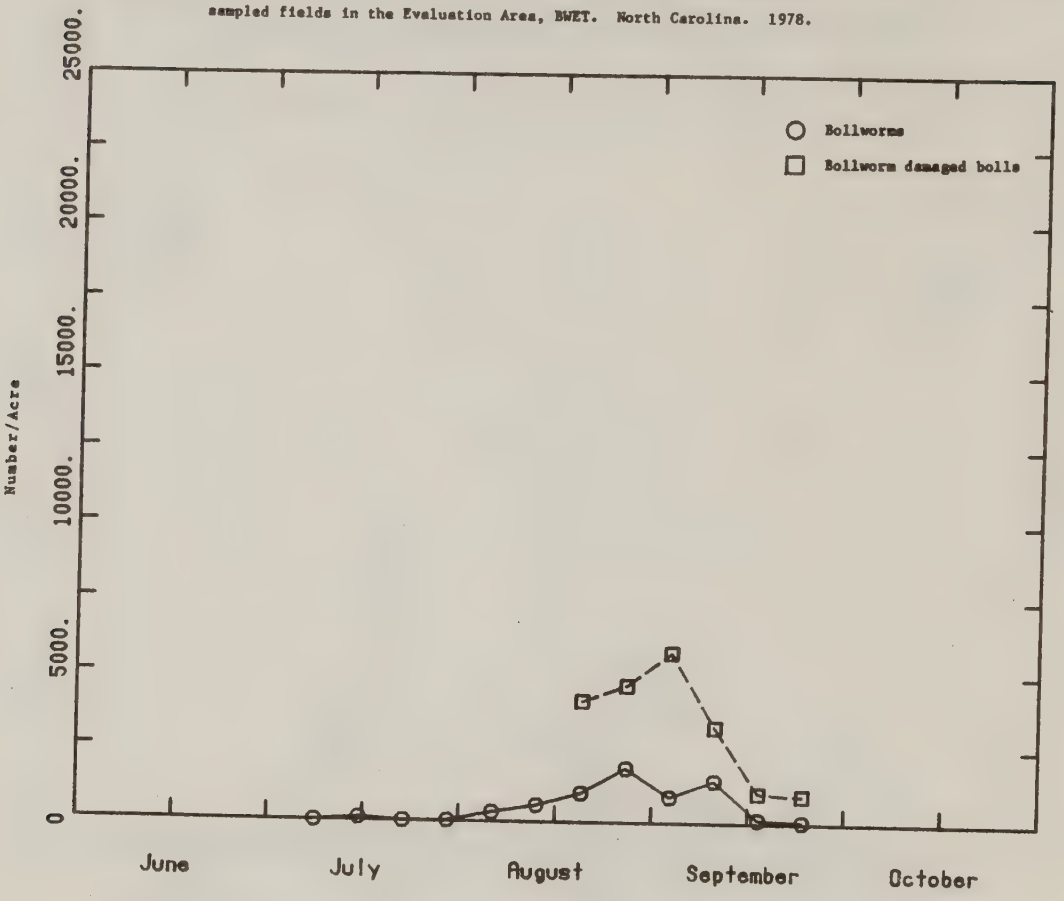


Figure 70. Estimated no. of bollworm larvae and no. of bollworm damaged bolls per acre in intensively sampled fields in the Evaluation Area, BWET. North Carolina. 1979.

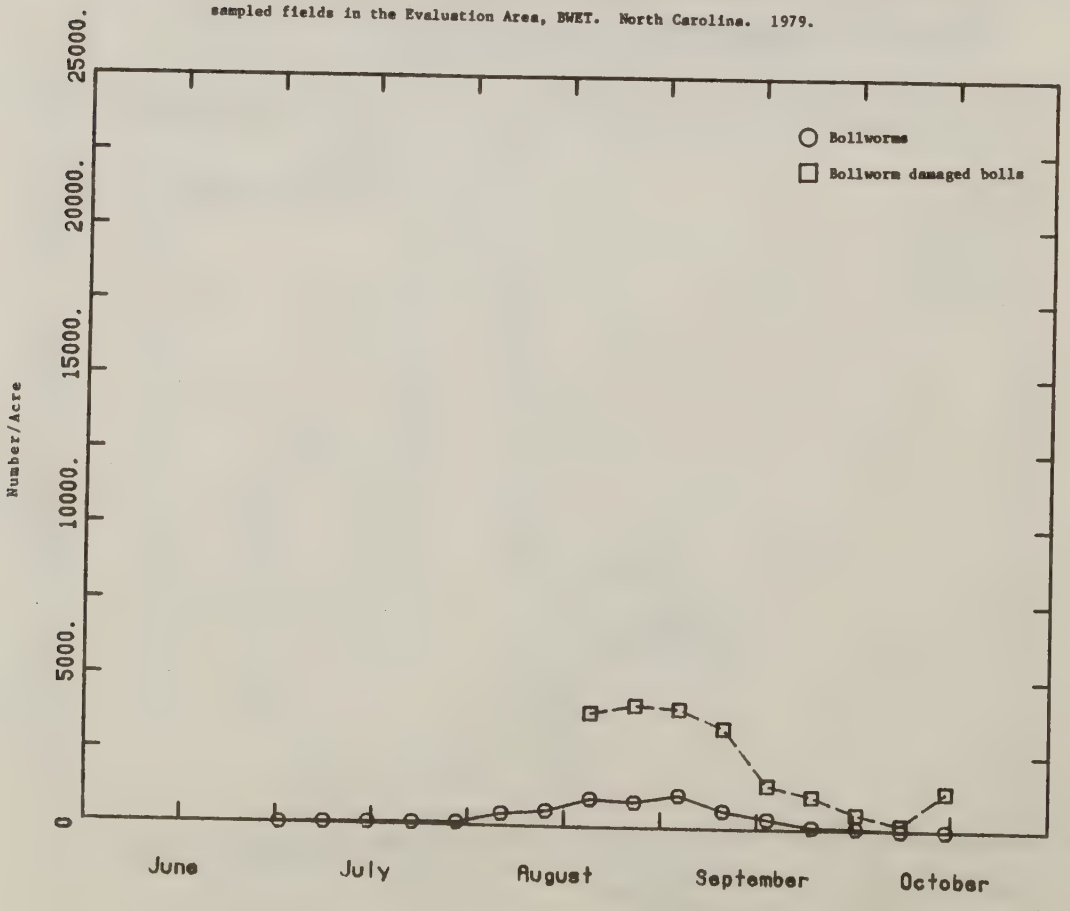


Figure 71. Estimated no. of bollworm larvae and no. of bollworm damaged bolls per acre in sampled fields in the Evaluation Area, BWET. North Carolina. 1980.

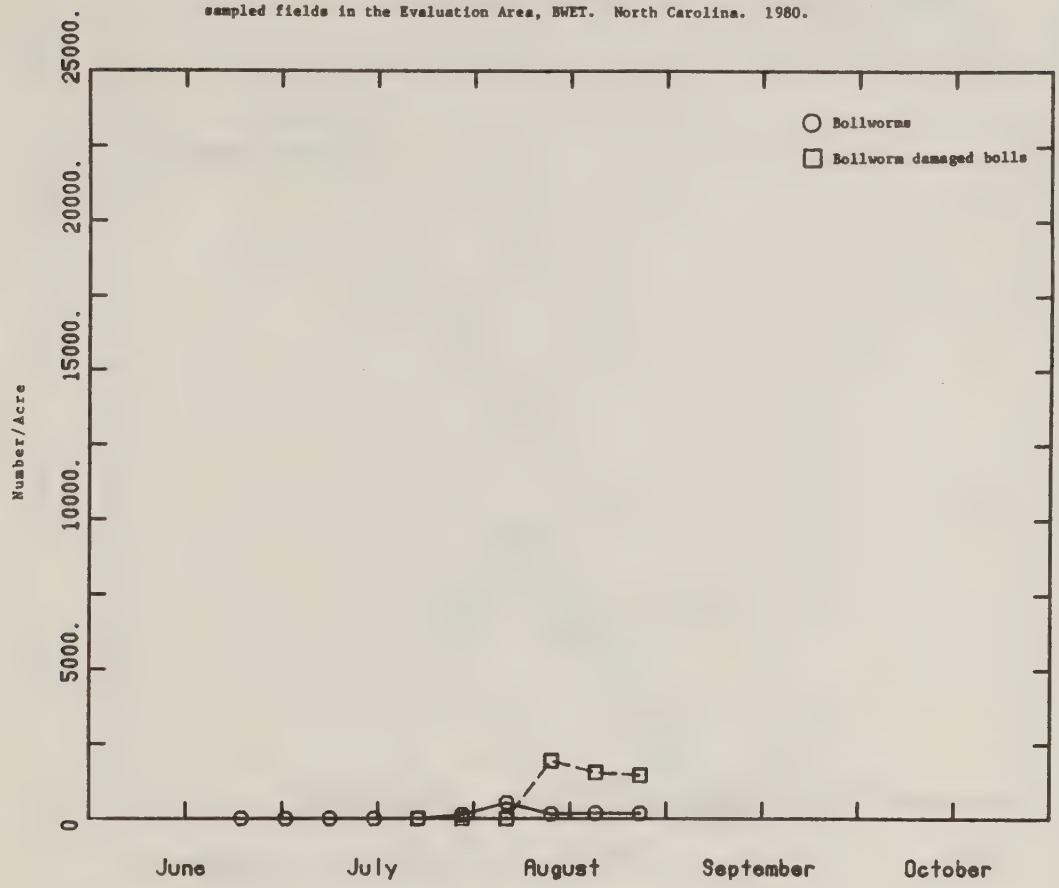


Figure 72. Estimated no. of bollworms and bollworm damaged bolls per acre in intensively sampled field in the Buffer Area, BWET. North Carolina. 1978.

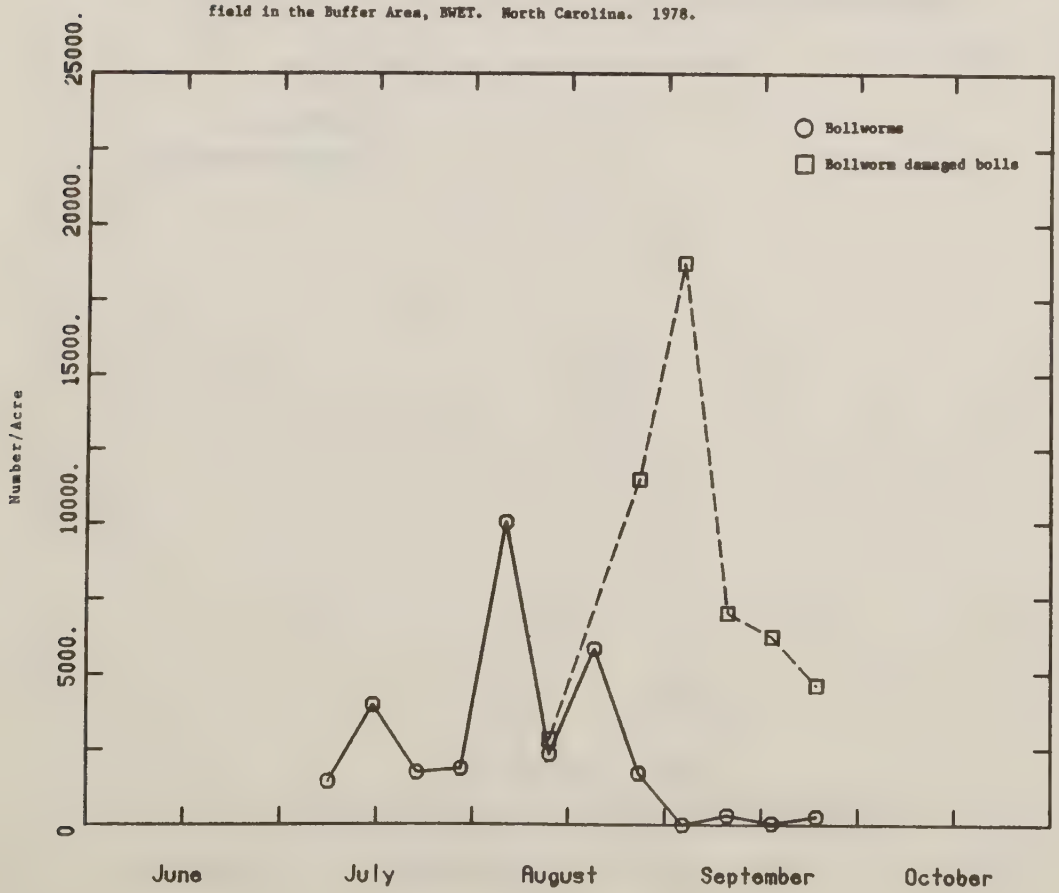


Figure 73. Estimated no. of bollworms and bollworm damaged bolls per acre in intensively sampled fields in the Buffer Area, BWET. North Carolina. 1979.

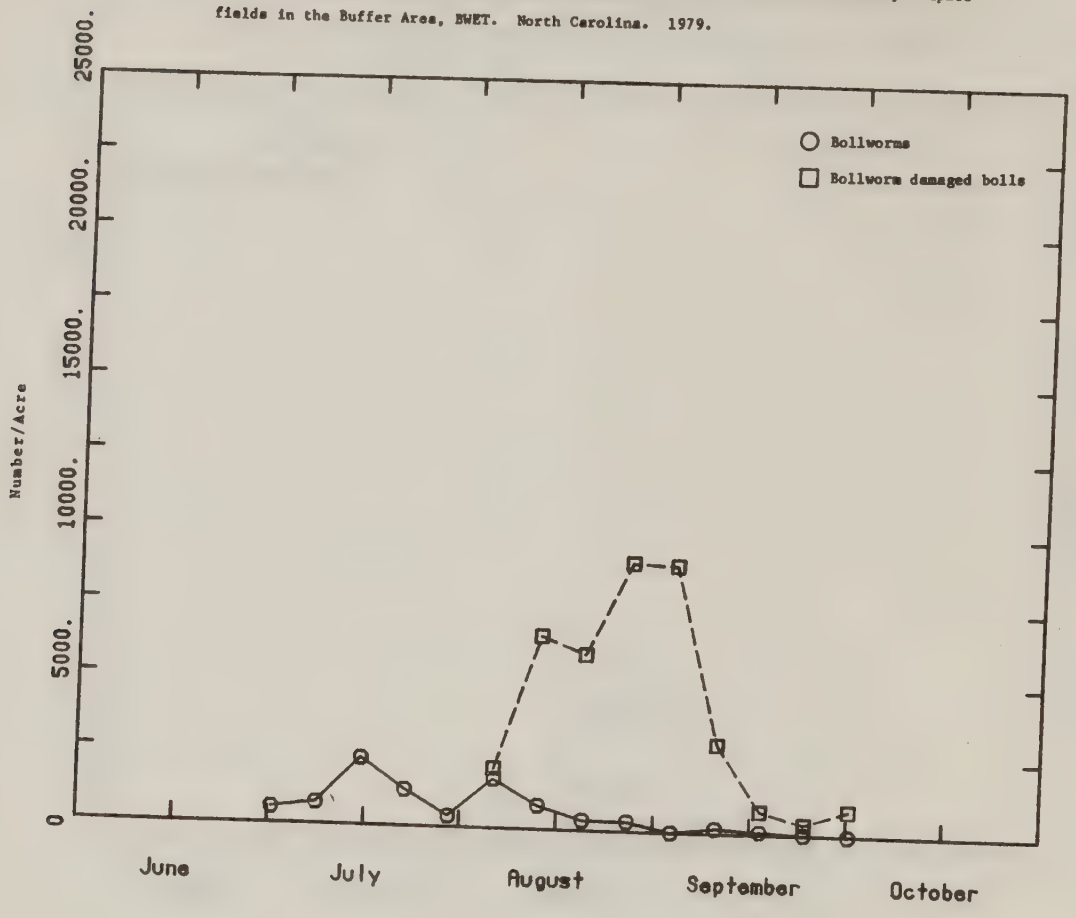


Figure 74. Estimated no. of bollworms and bollworm damaged bolls per acre in intensively sampled field in the Buffer Area, BWET. North Carolina. 1980.

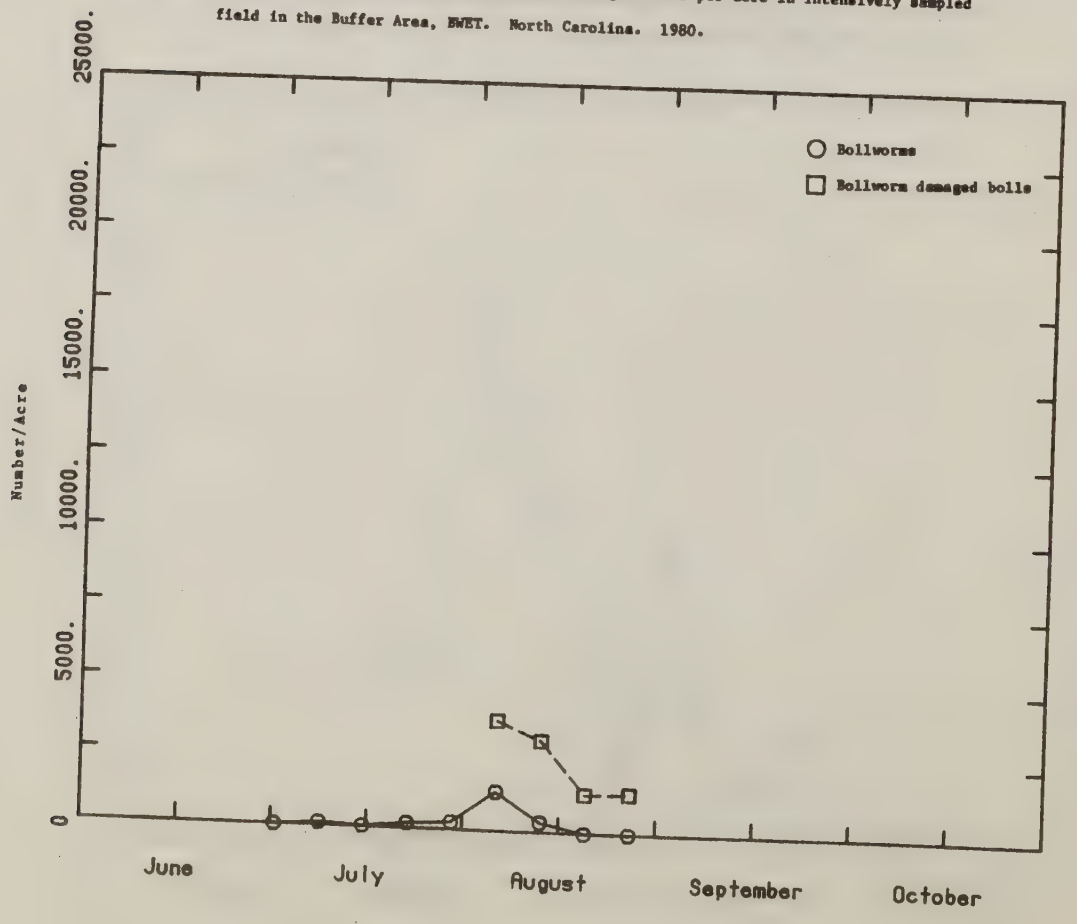


Figure 75. Estimated no. of bollworms and bollworm damaged bolls per acre in sample fields in Chowan County, BWET. North Carolina. 1977.

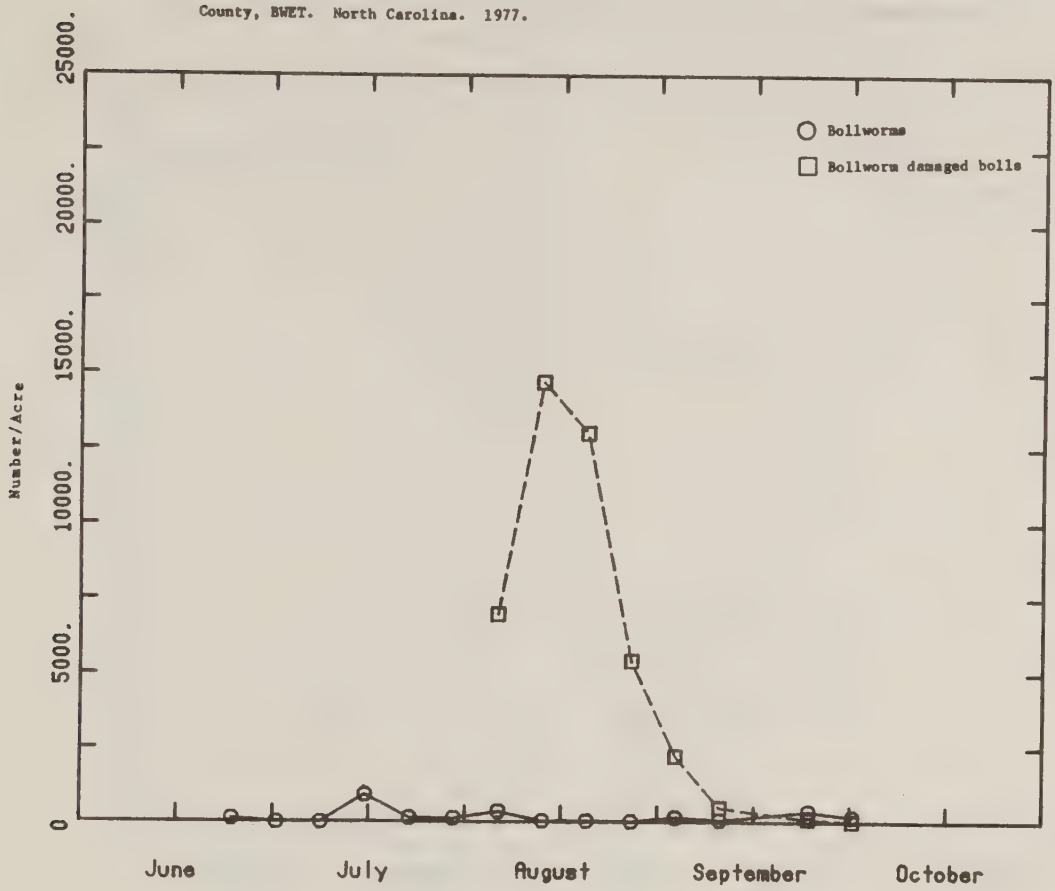


Figure 76. Estimated no. of bollworms and bollworm damaged bolls per acre in intensively sampled fields in Chowan County, BWET. North Carolina. 1978.

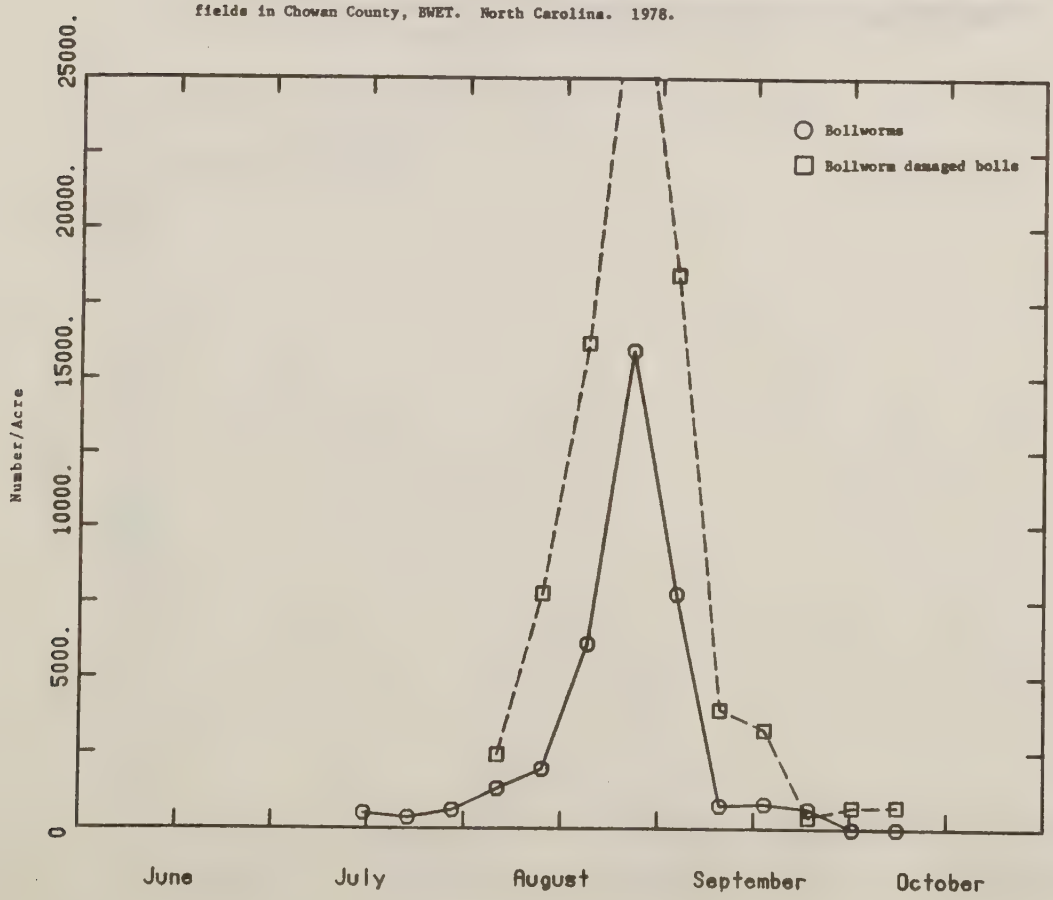


Figure 77. Estimated no. of bollworms and bollworm damaged bolls per acre in intensively sampled fields in Chowan County, EWET. North Carolina. 1979.

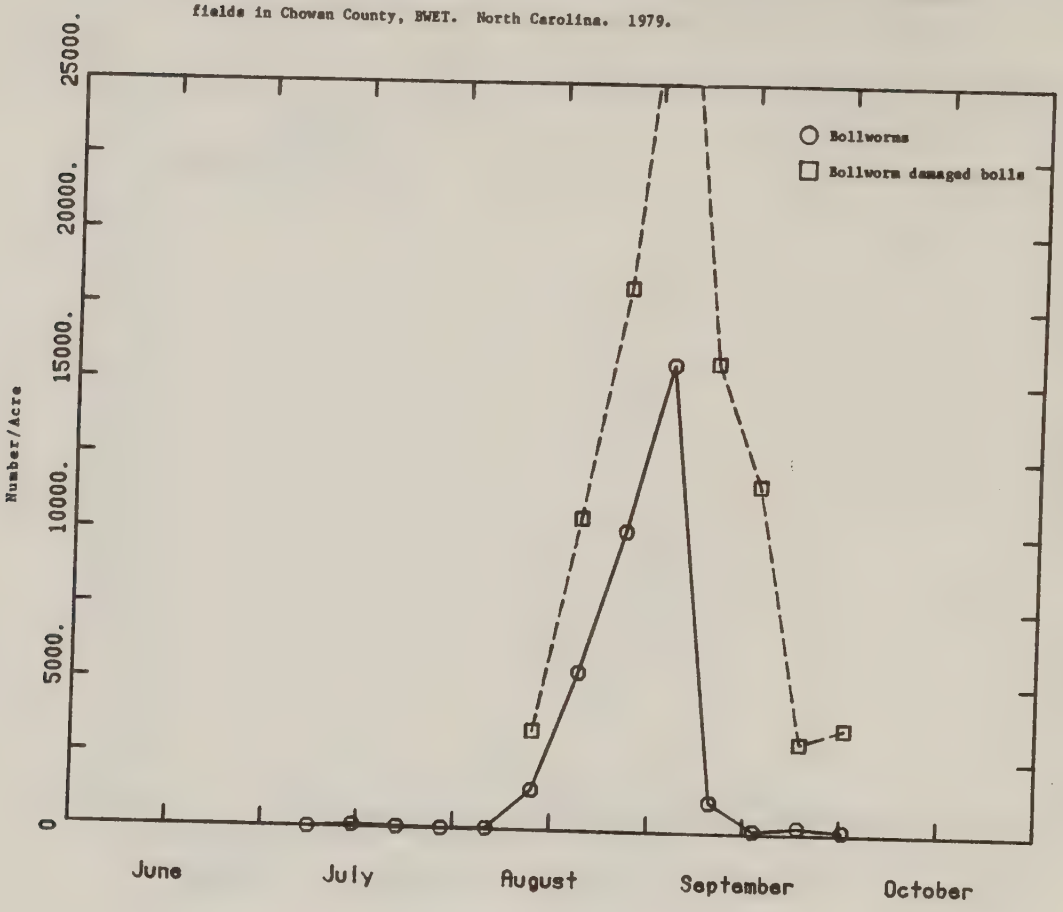


Figure 78. Estimated no. of bollworms and bollworm damaged bolls per acre in intensively sampled fields in Chowan County, EWET. North Carolina. 1980.

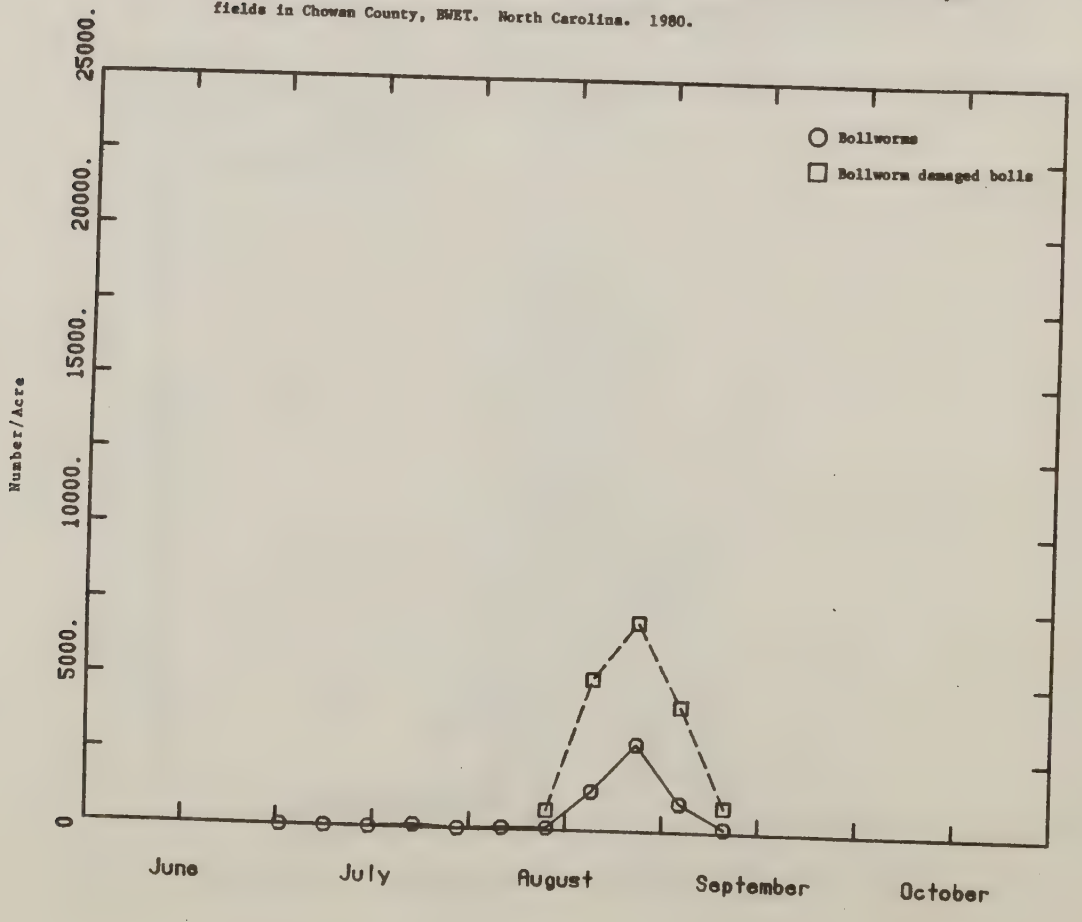


Figure 79. Estimated no. of bollworm larvae and bollworm damaged bolls per acre in sampled fields in Scotland-Robeson counties outside BWET area. North Carolina. 1977.

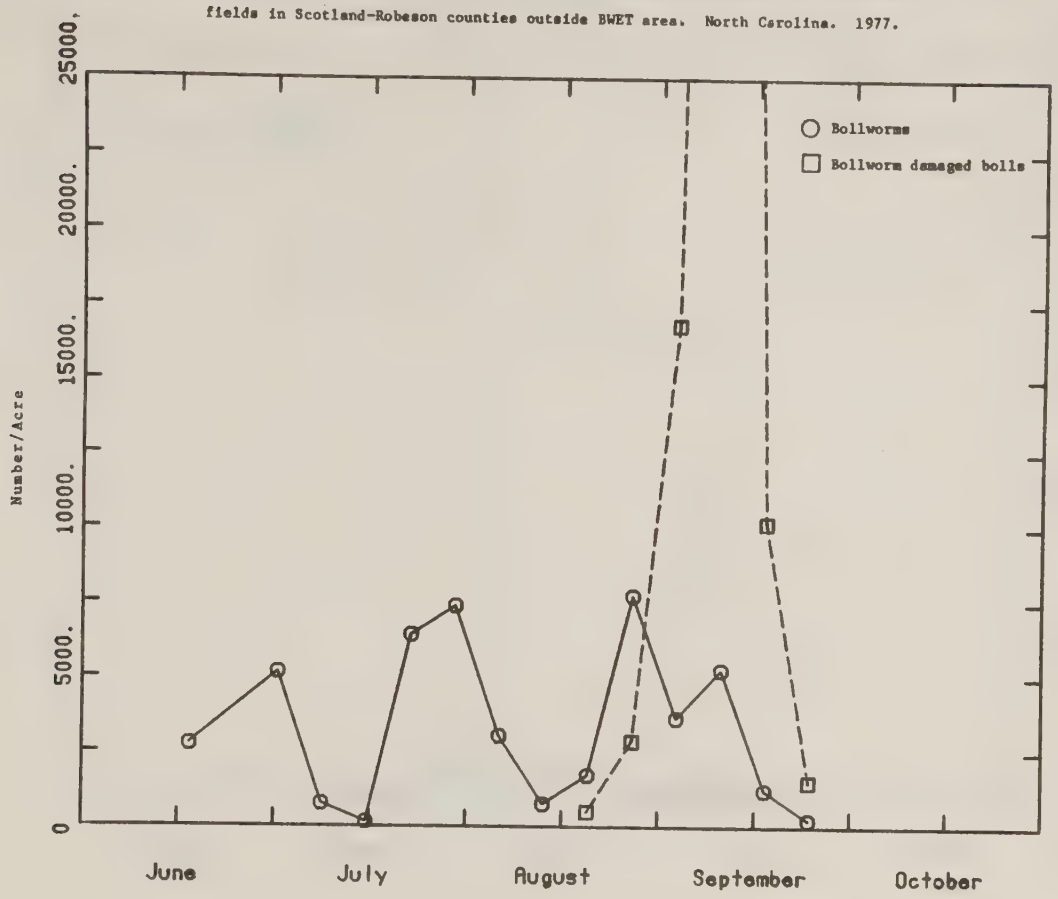


Figure 80. Estimated no. of bollworm larvae and bollworm damaged bolls per acre in intensively sampled fields in Scotland-Robeson counties outside BWET area. North Carolina. 1978.

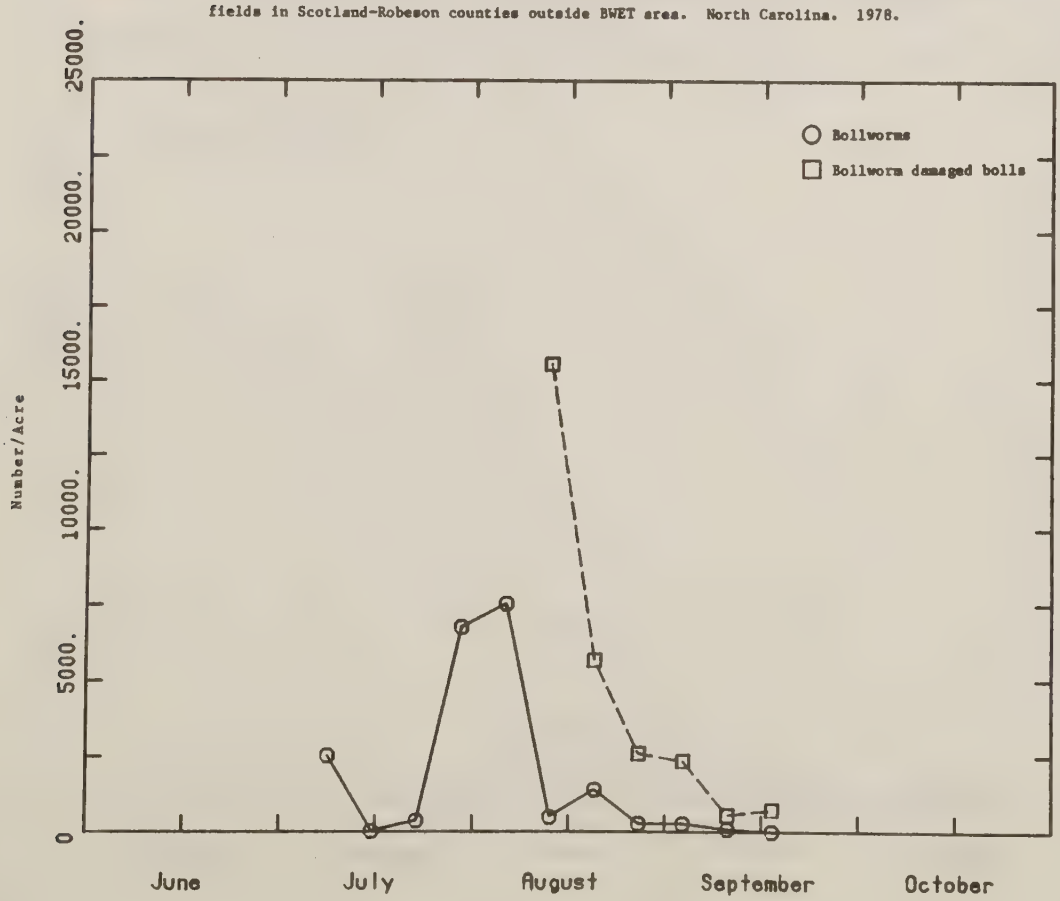


Figure 81. Estimated no. of bollworm larvae and bollworm damaged bolls per acre in intensively sampled fields in Scotland-Robeson counties outside BWET area. North Carolina. 1979.

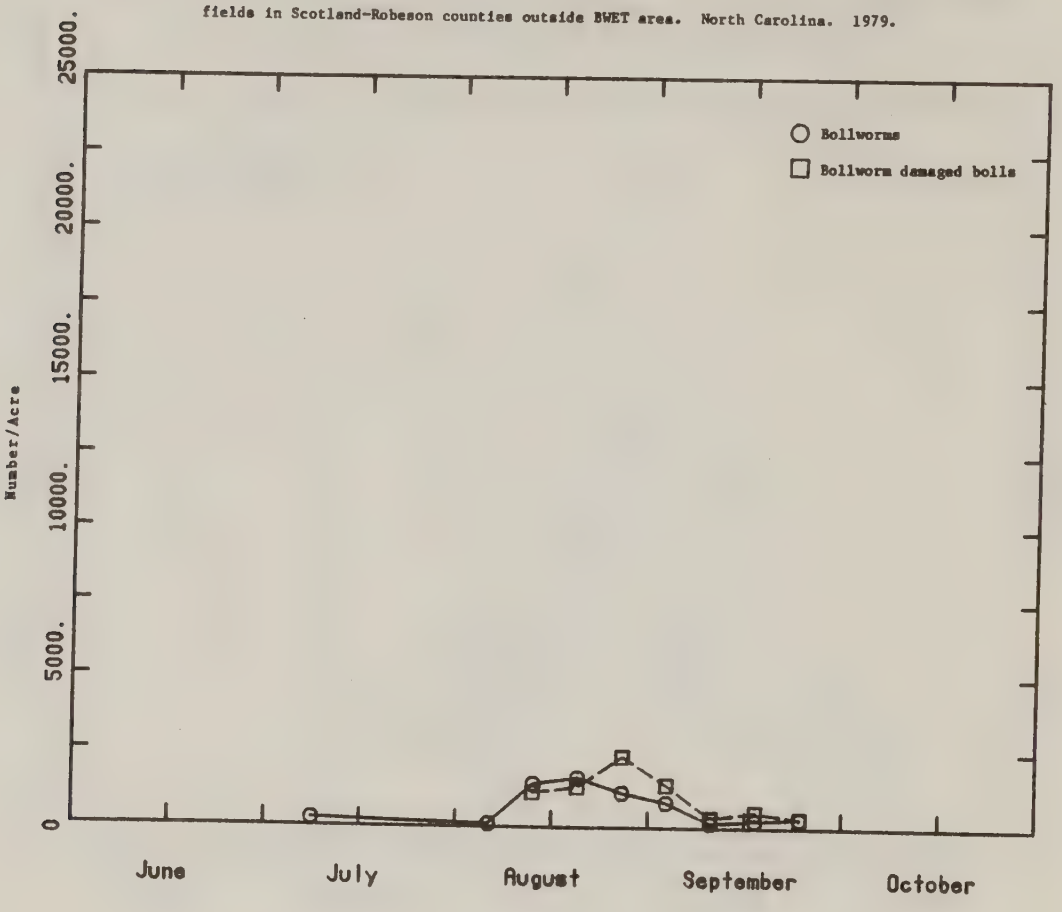


Figure 82. Estimated no. of bollworm larvae and bollworm damaged bolls per acre in intensively sampled fields in Scotland-Robeson counties outside BWET area. North Carolina. 1980.

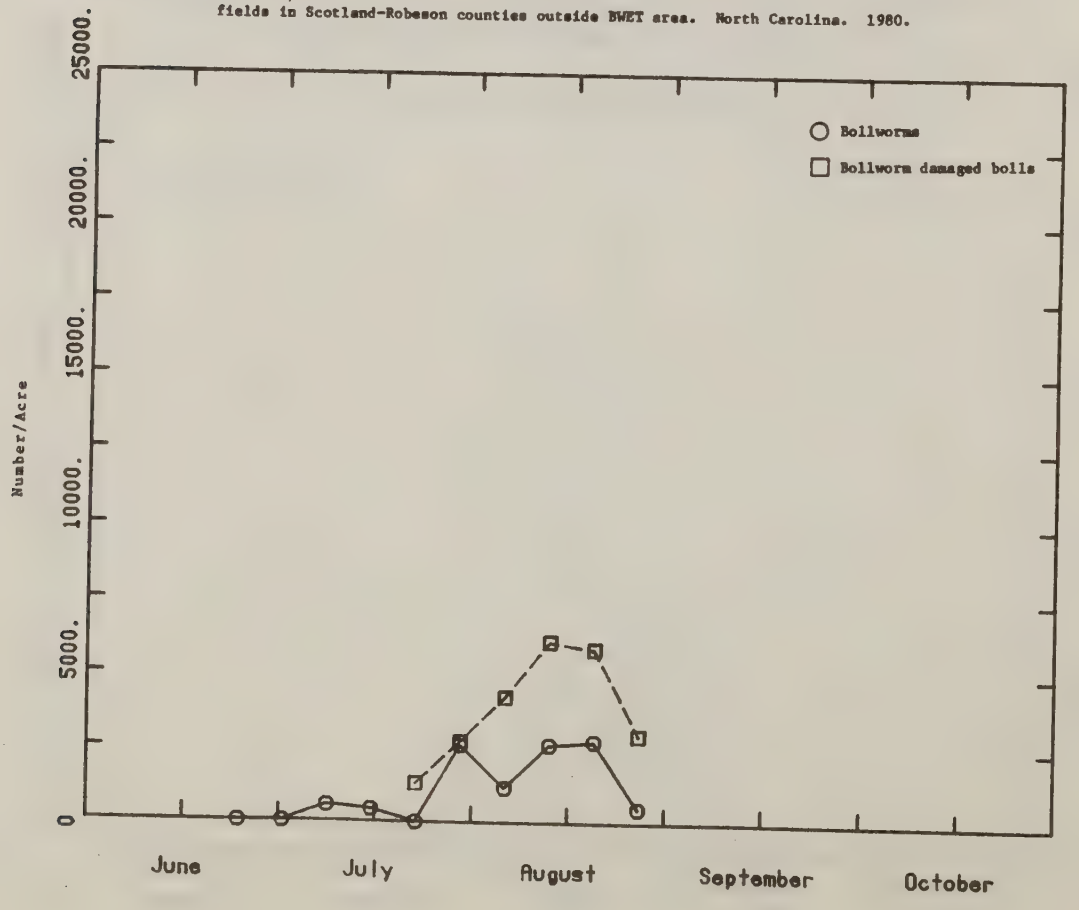


Figure 83. Estimated no. of bollworm larvae and bollworm damaged bolls per acre in sampled fields in Cleveland County outside BWET area. North Carolina. 1977.

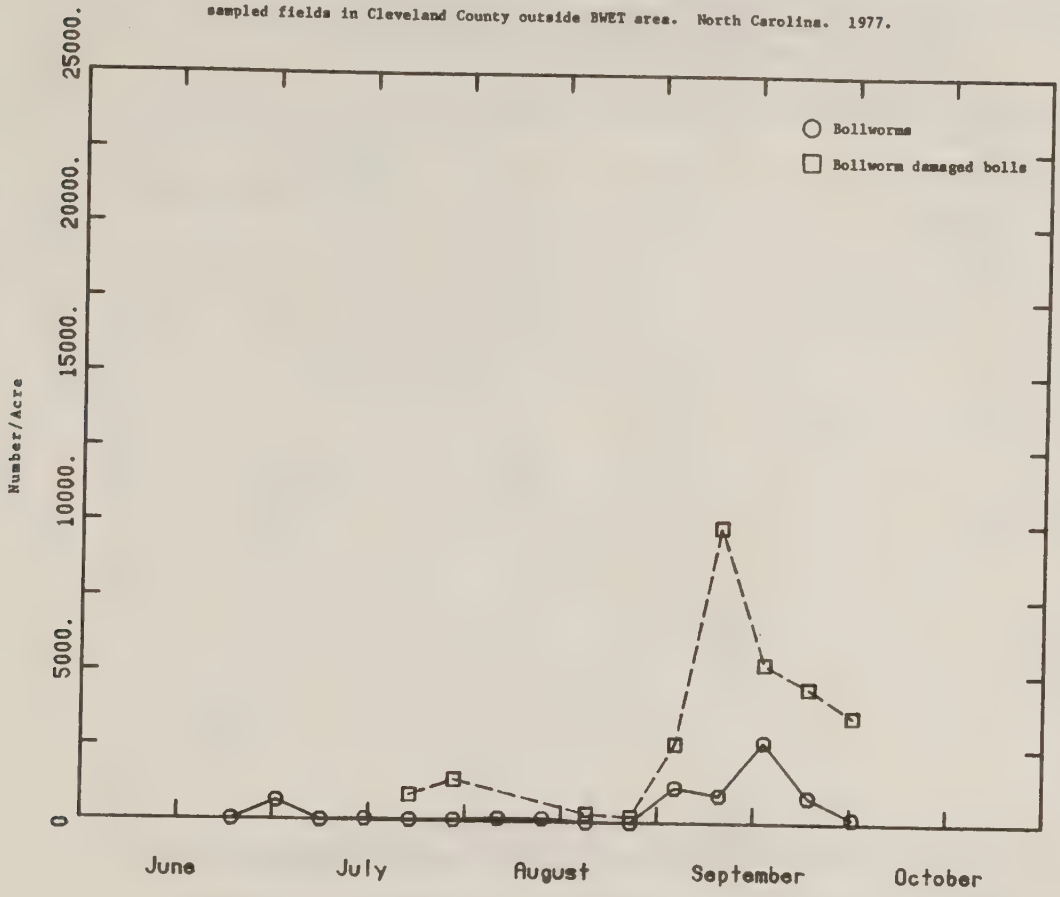


Figure 84. Estimated no. of bollworm larvae and bollworm damaged bolls per acre in intensively sampled fields in Cleveland County outside BWET area. North Carolina. 1978.

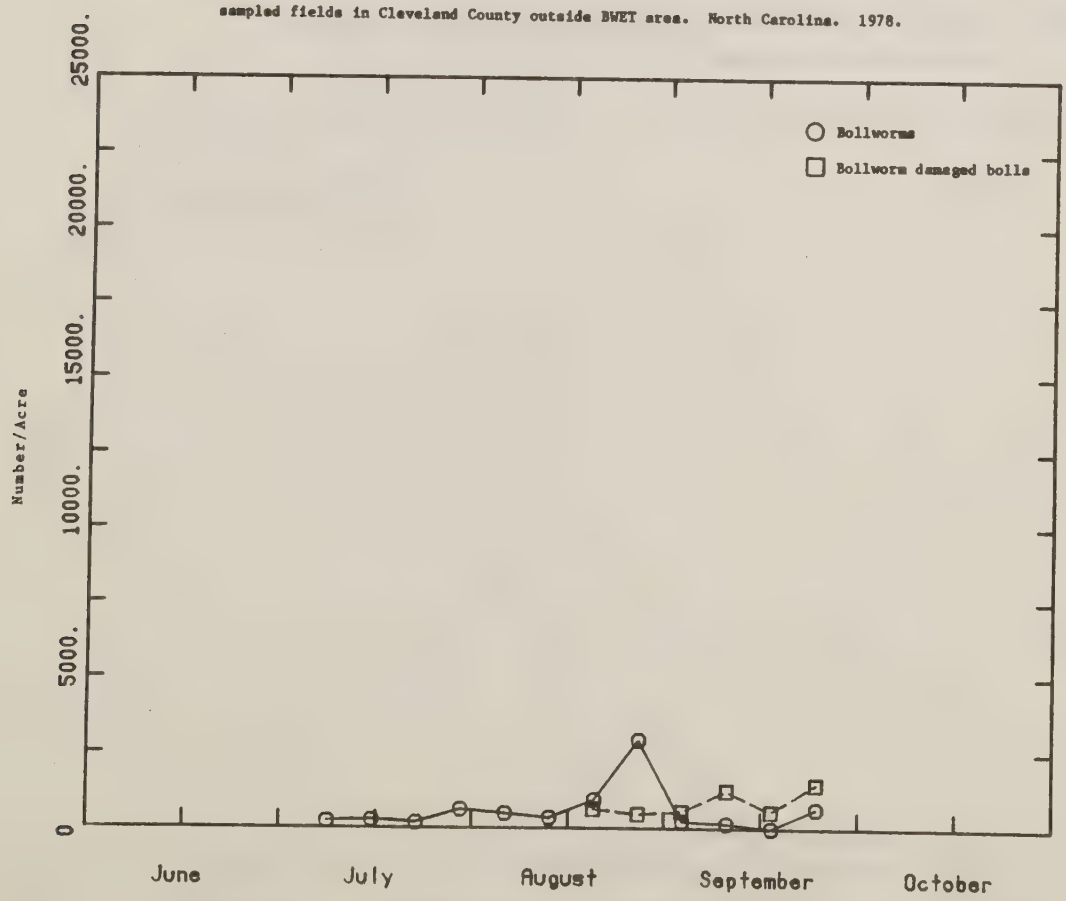


Figure 85. Estimated no. of bollworm larvae and bollworm damaged bolls per acre in intensively sampled fields in Cleveland County outside BWET area. North Carolina. 1979.

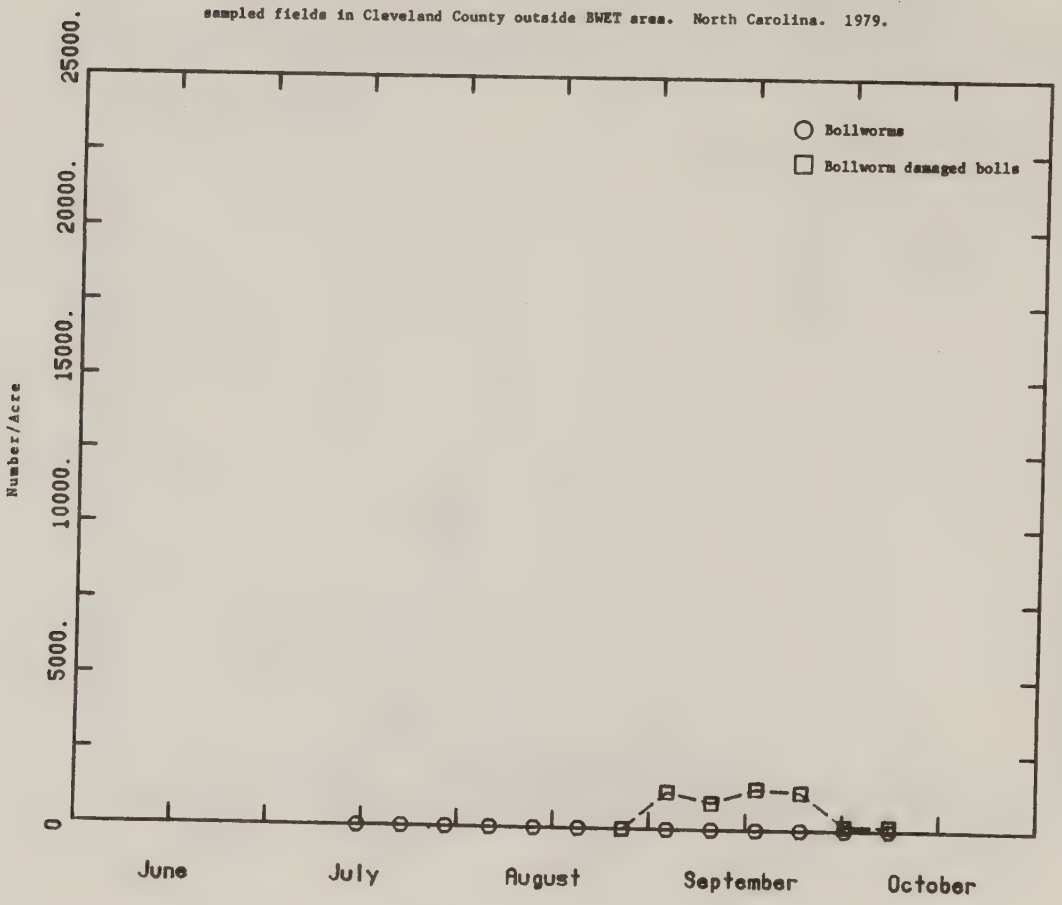


Figure 86. Estimated no. of bollworm larvae and bollworm damaged bolls per acre in intensively sampled fields in Cleveland County outside BWET area. North Carolina. 1980.

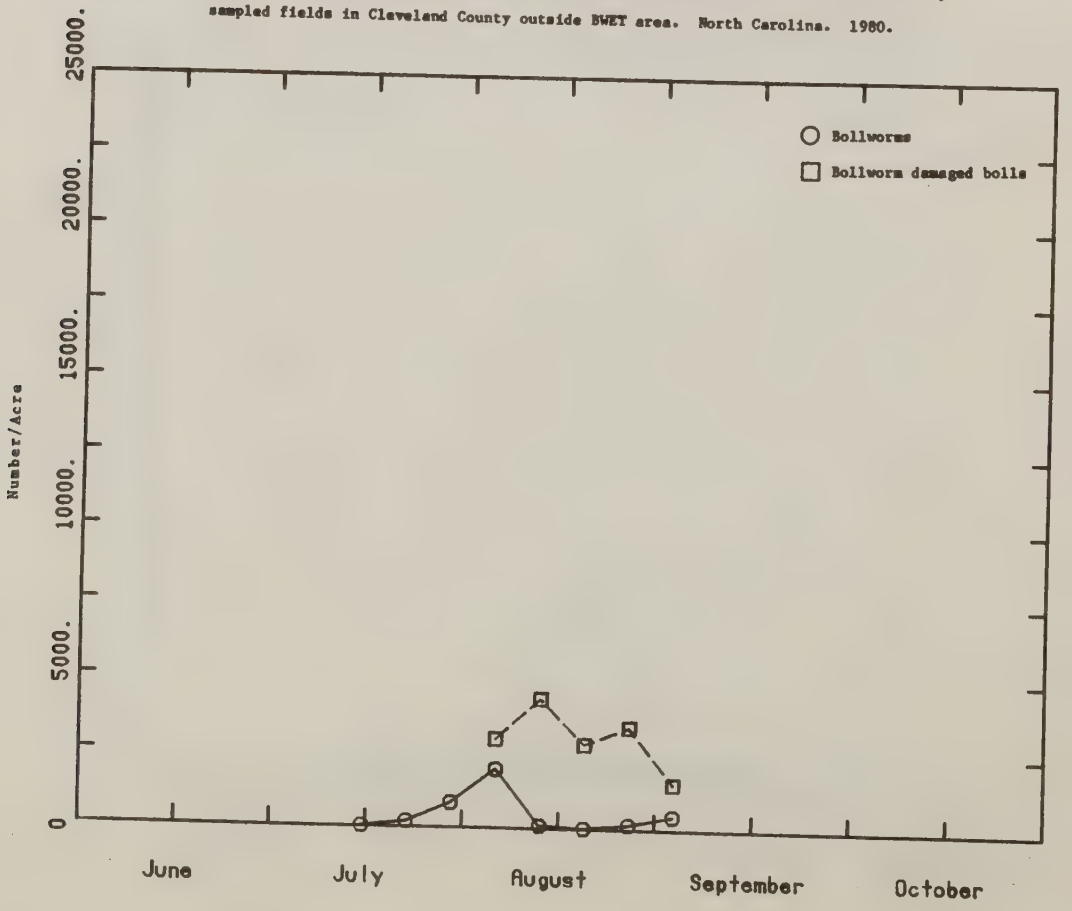


Figure 87. Estimated no. of beneficial insects per acre in 1977 sampled fields and 1978, 1979, and 1980 intensively sampled fields in the Evaluation Area, BWET. North Carolina.

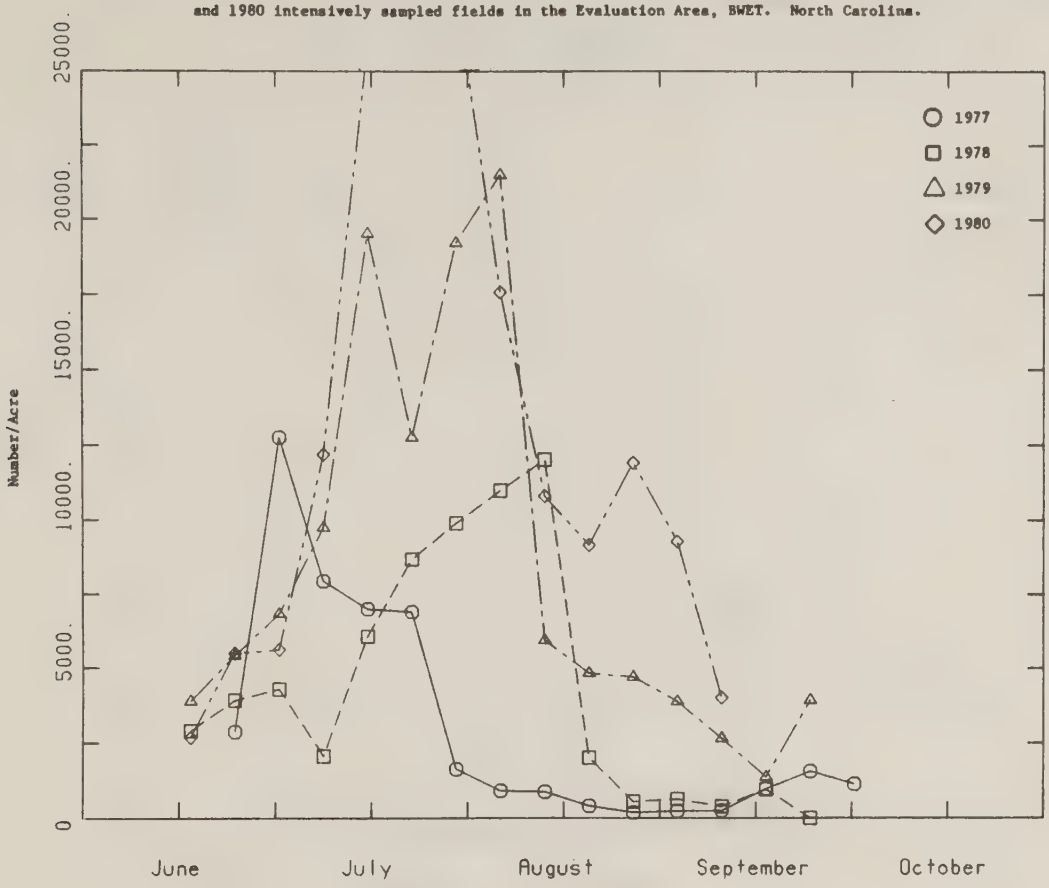


Figure 88. Estimated no. of important beneficial insects per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in the Evaluation Area, BWET. North Carolina.

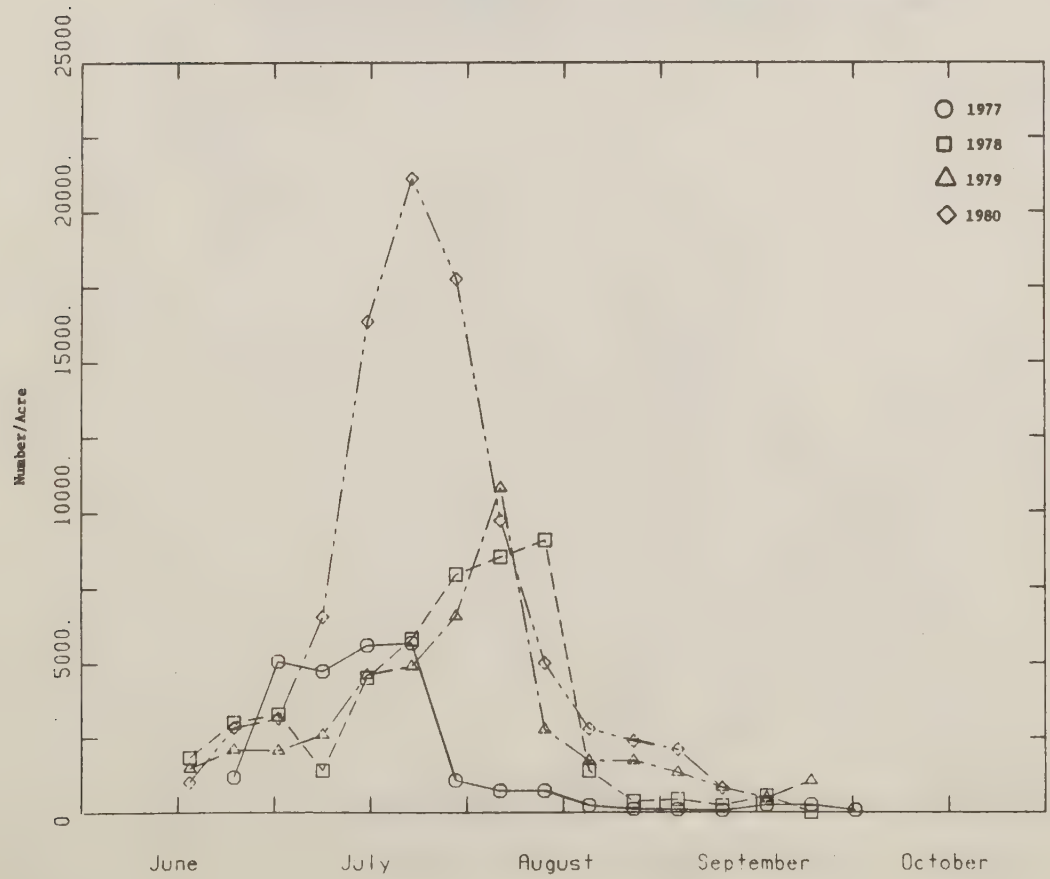


Figure 89. Estimated no. of Geocoris sp. per acre in 1977 sampled fields and 1978, 1979, and 1980 intensively sampled fields in the Evaluation Area, BWET. North Carolina.

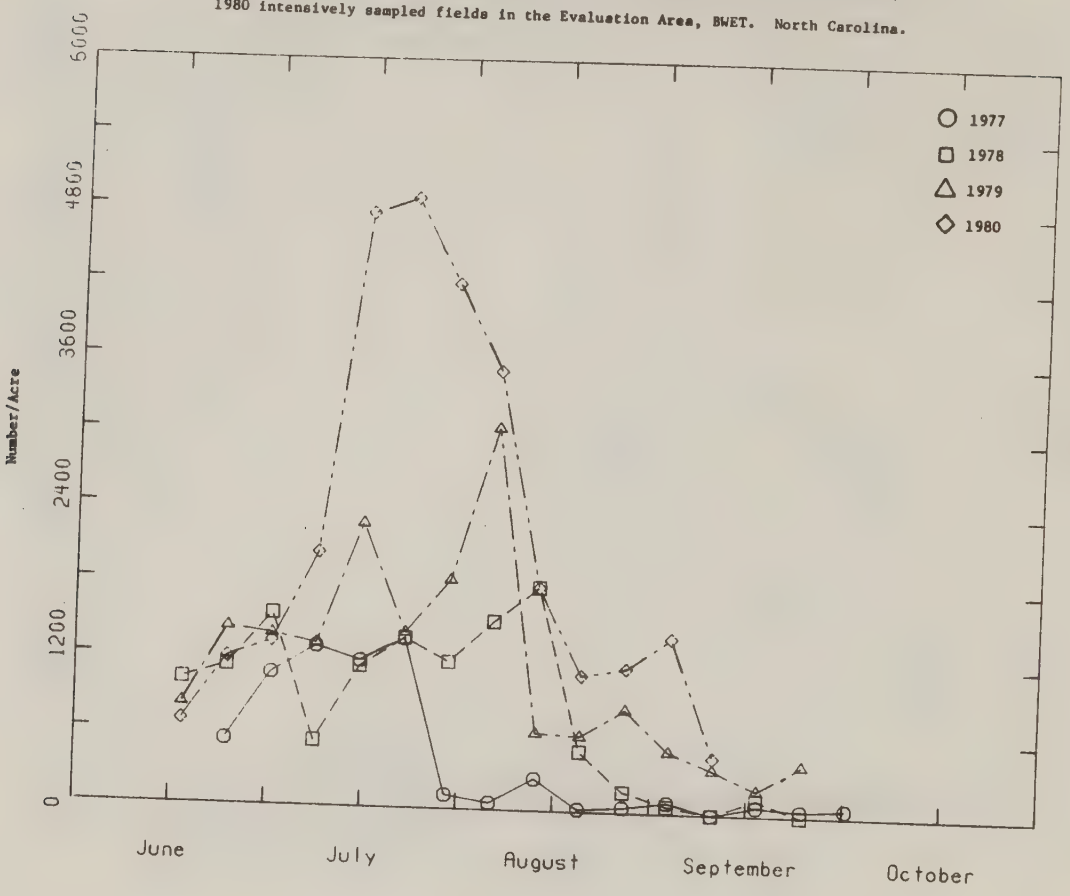


Figure 90. Estimated no. of Orius insidiosus per acre in 1977 sampled fields and 1978, 1979, and 1980 intensively sampled fields in the Evaluation Area, BWET. North Carolina.

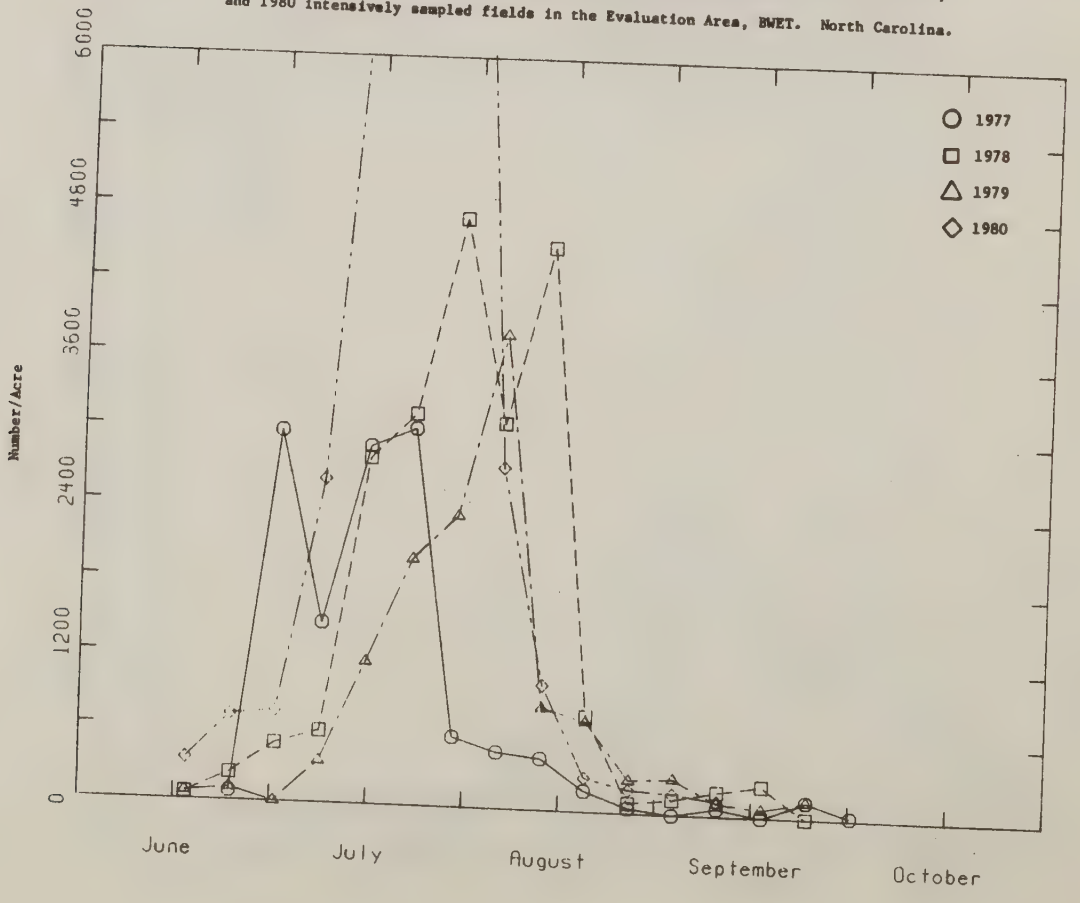


Figure 91. Estimated no. of Hippodamia convergens per acre in 1977 sampled fields and 1978, 1979, and 1980 intensively sampled fields in the Evaluation Area, BWET. North Carolina.

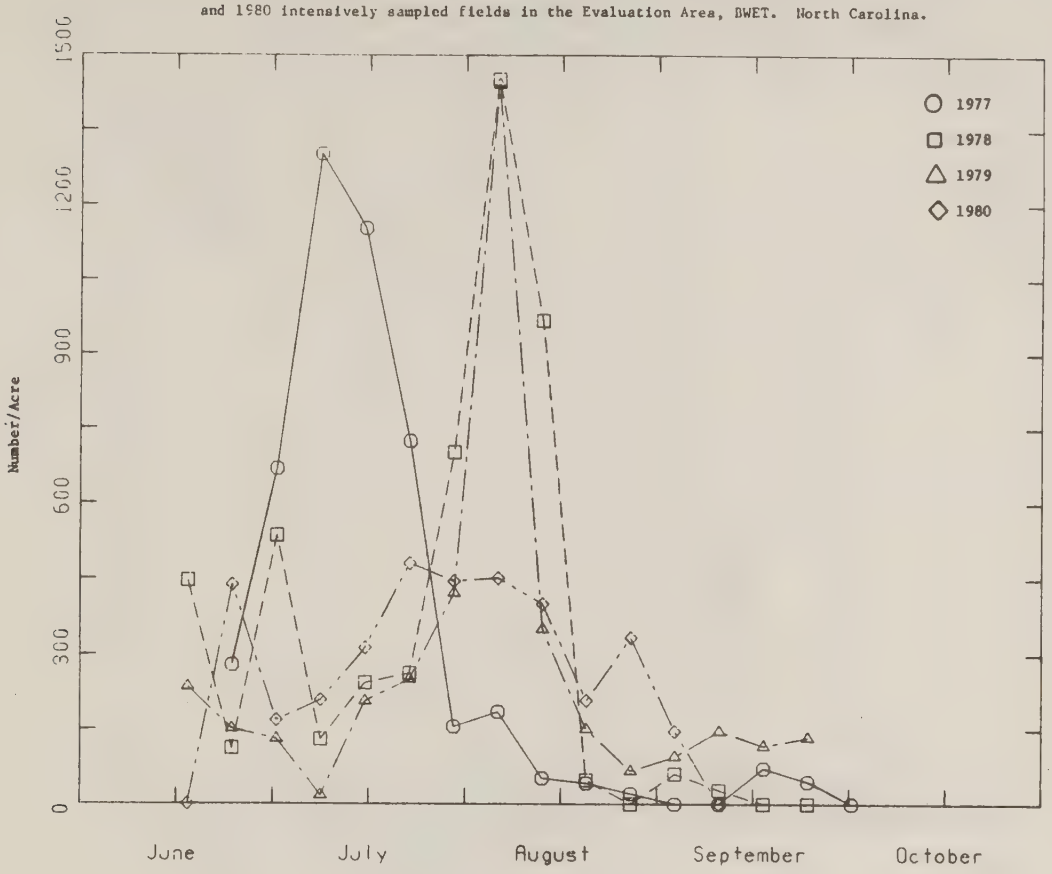


Figure 92. Estimated no. of Coleomegilla maculata per acre in 1977 sampled fields and 1978, 1979, and 1980 intensively sampled fields in the Evaluation Area, BWET. North Carolina.

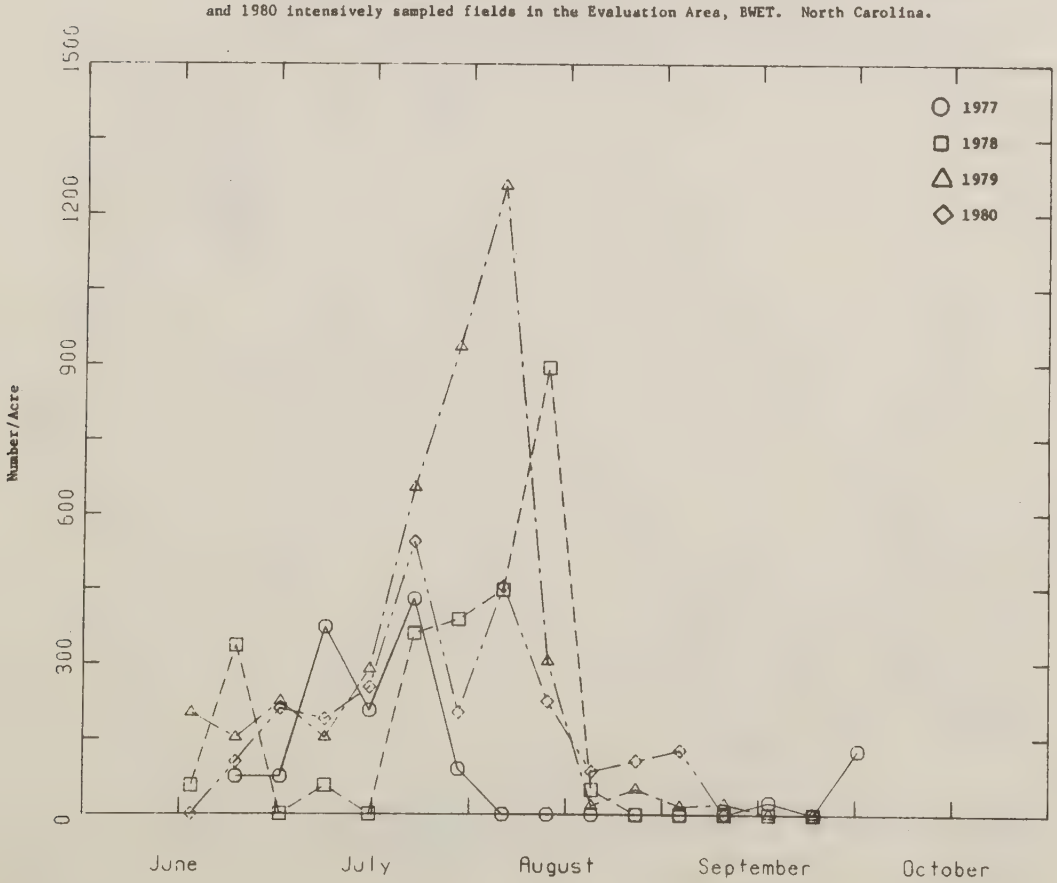


Figure 93. Estimated no. of Chrysopa sp. per acre in 1977 sampled fields and 1978, 1979, and 1980 intensively sampled fields in the Evaluation Area, BWET. North Carolina.

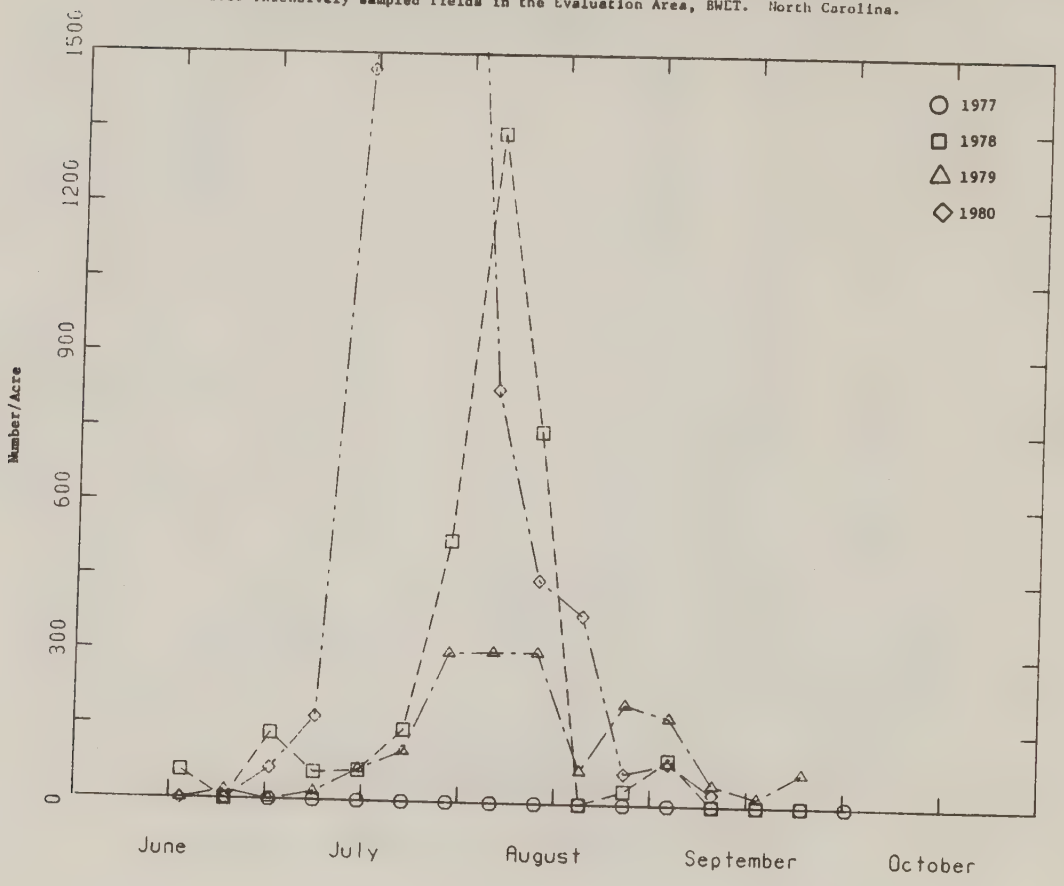


Figure 94. Estimated no. of Nabids per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in the Evaluation Area, BWET. North Carolina.

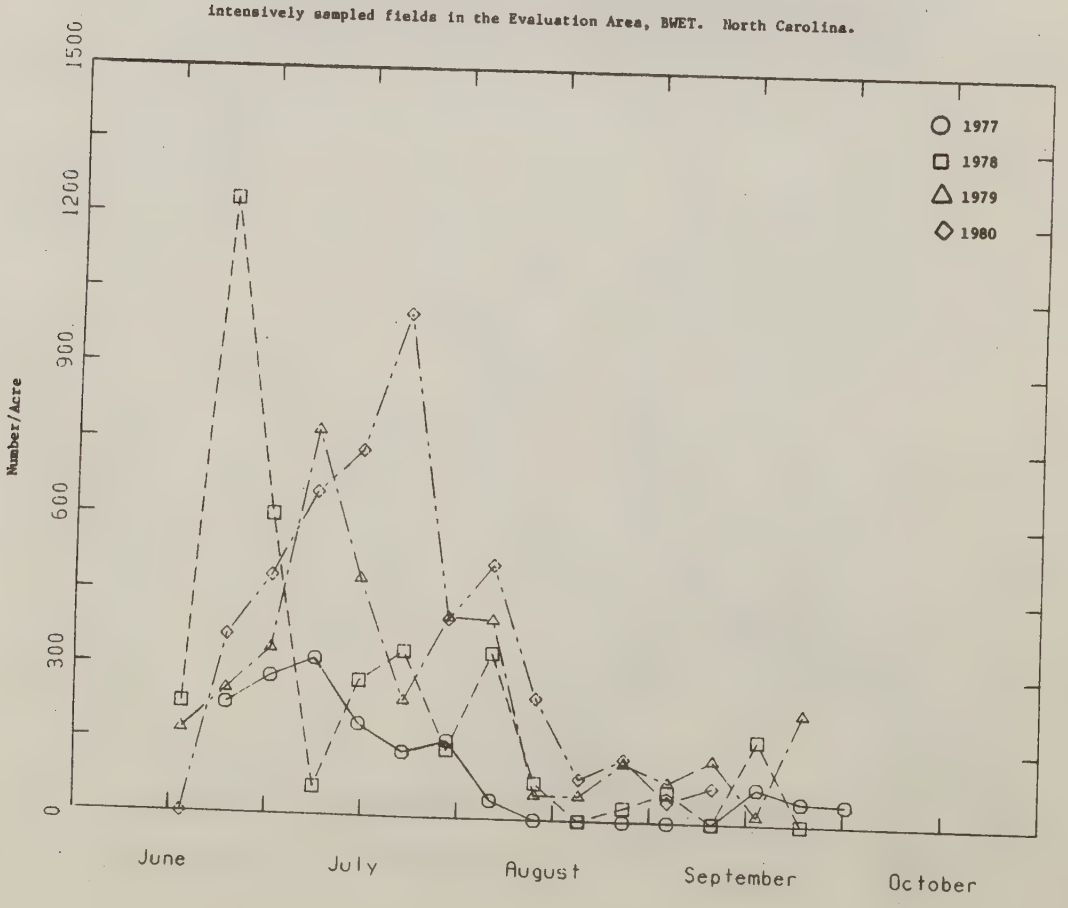


Figure 95. Estimated no. of Lynx spiders per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in the Evaluation Area, BWET. North Carolina.

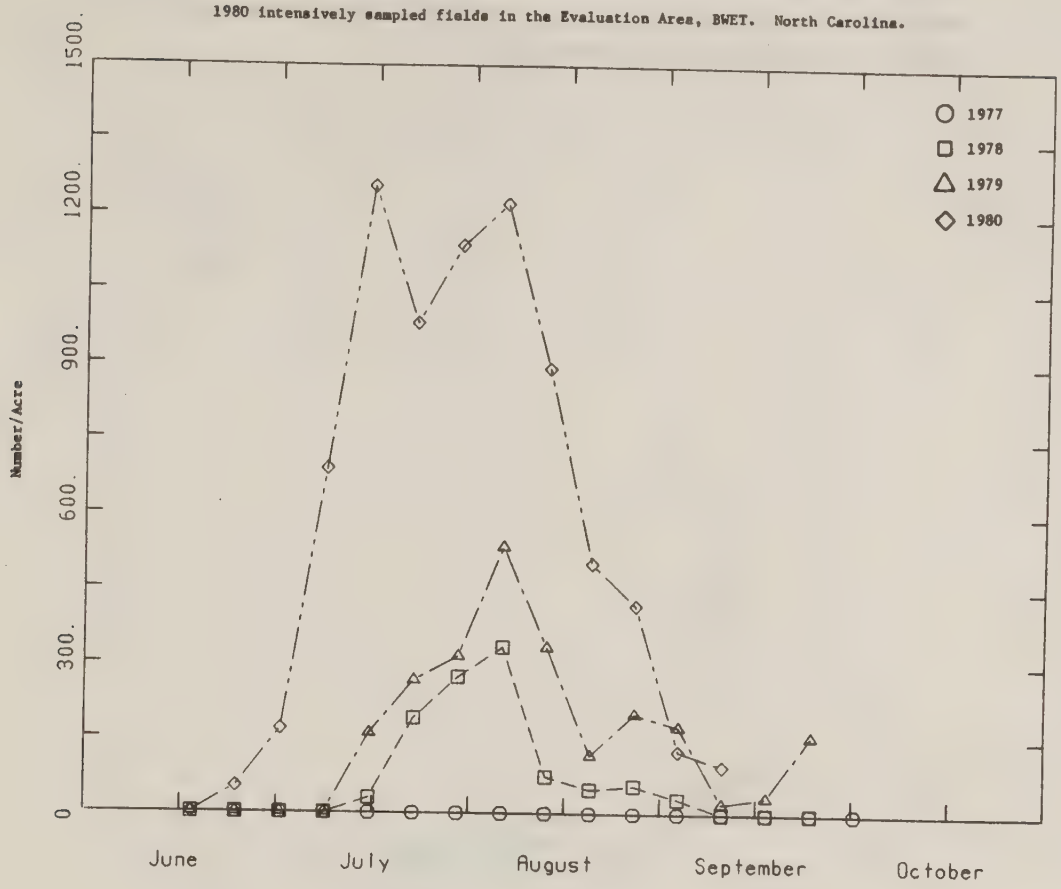


Figure 96. Estimated no. of beneficial insects per acre in 1978, 1979, and 1980 intensively sampled fields in the Buffer Area, BWET. North Carolina.

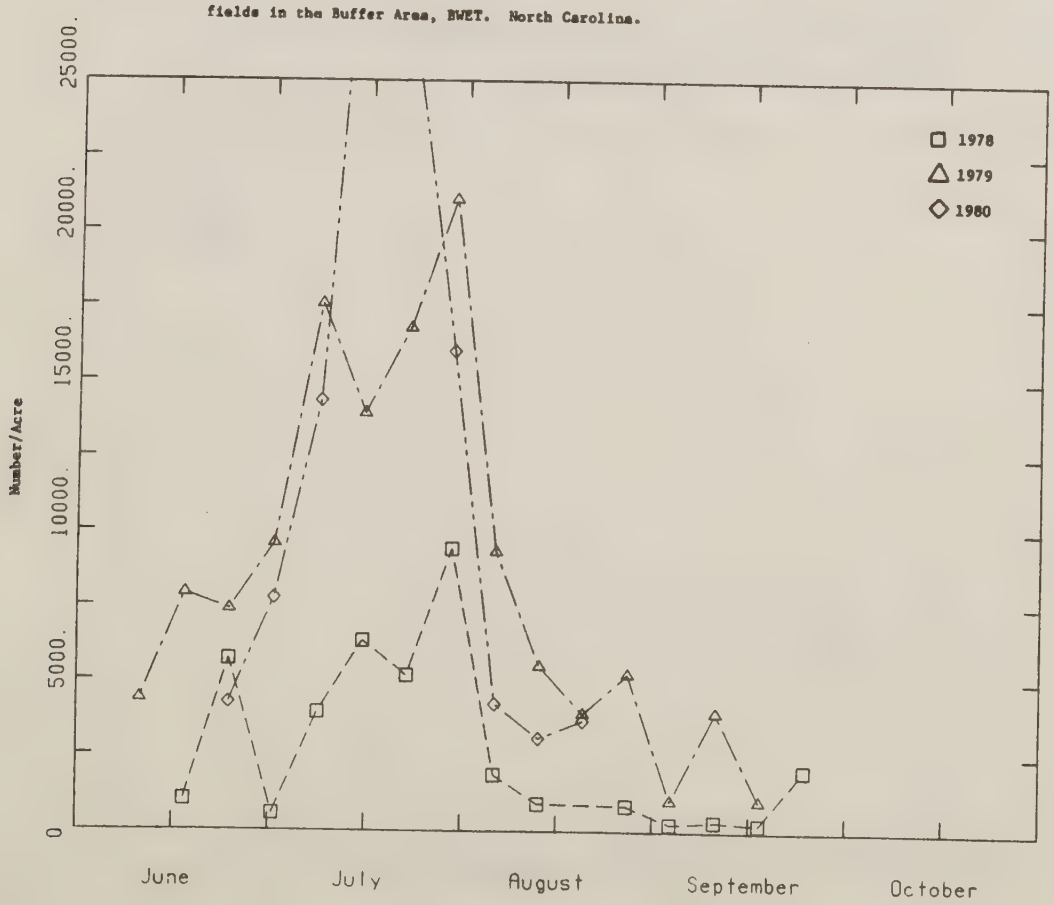


Figure 97. Estimated no. of important beneficial insects per acre in 1978, 1979 and 1980 intensively sampled fields in the Buffer Area, BWET. North Carolina.

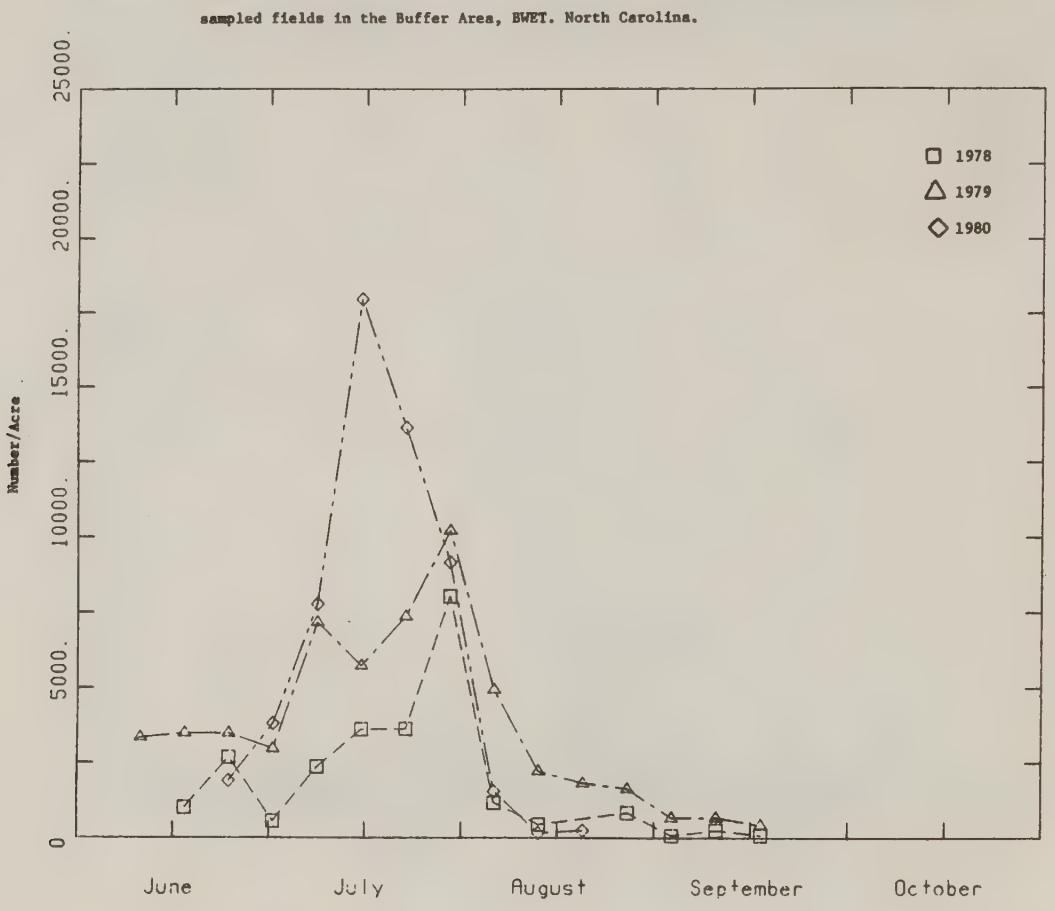


Figure 98. Estimated no. of Geocoris sp. per acre in 1978, 1979 and 1980 intensively sampled fields in the Buffer Area, BWET. North Carolina.

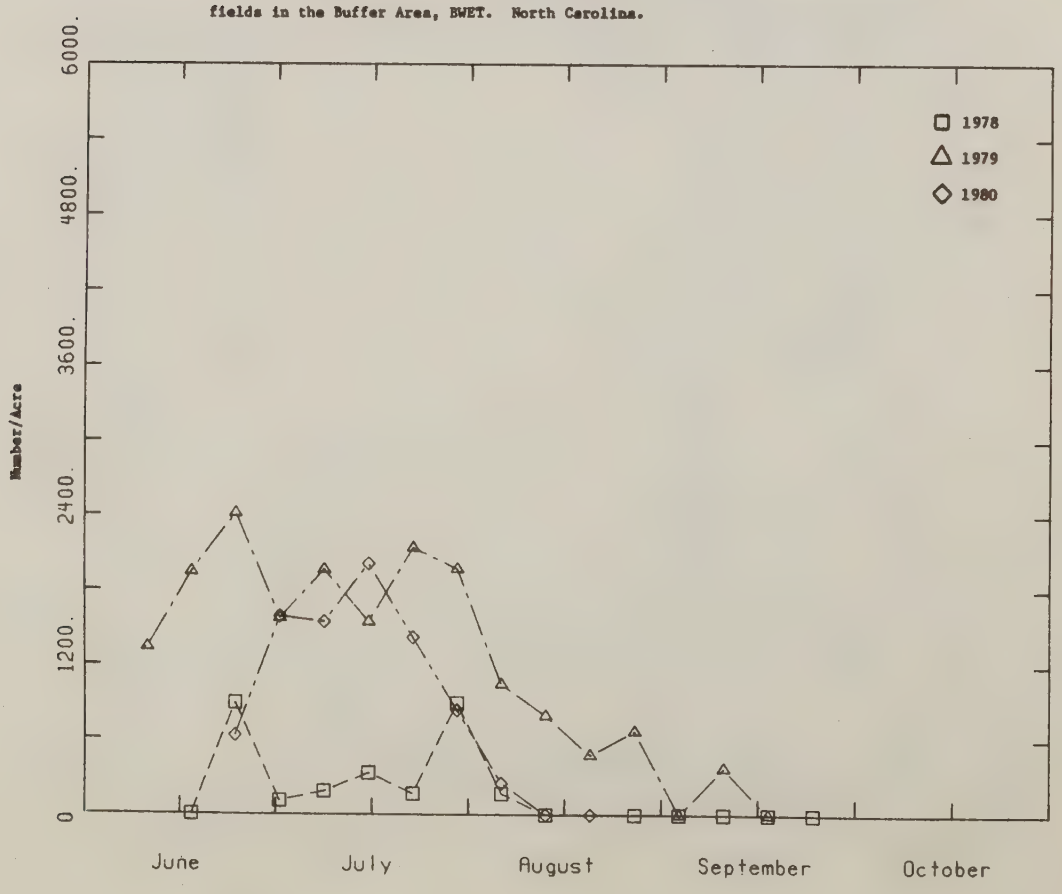


Figure 99. Estimated no. of Orius insidiosus per acre in 1978, 1979 and 1980 intensively sampled fields in the Buffer Area, BWET. North Carolina.

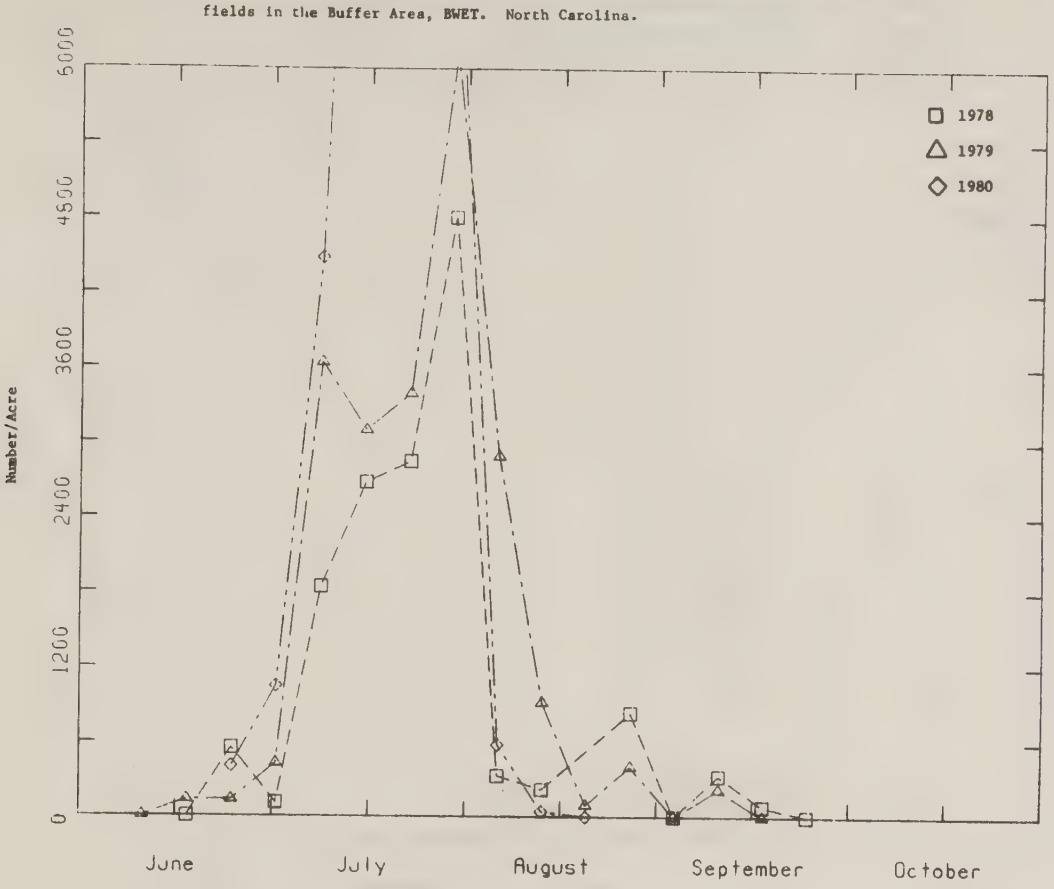


Figure 100. Estimated no. of Hippodamia convergens per acre in 1978, 1979 and 1980 intensively sampled fields in the Buffer Area, BWET. North Carolina.

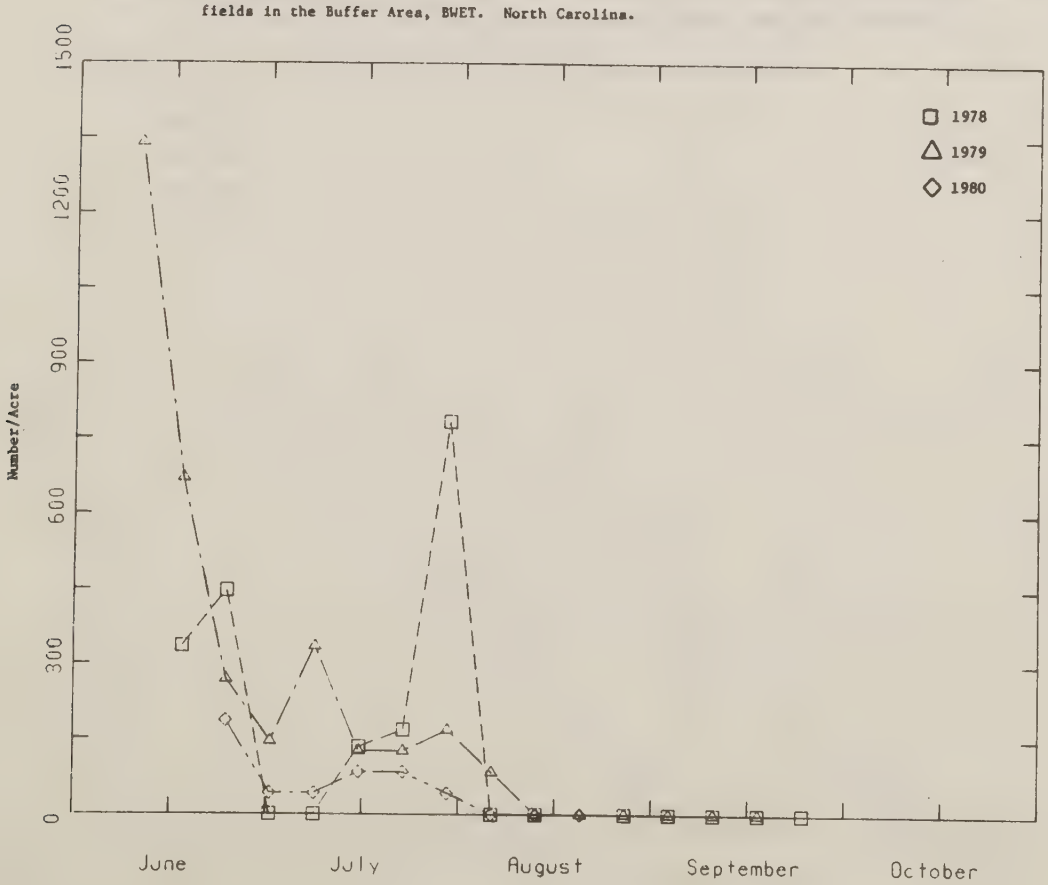


Figure 101. Estimated no. of Coleomegilla maculata per acre in 1978, 1979 and 1980 intensively sampled fields in the Buffer Area, BWET. North Carolina.

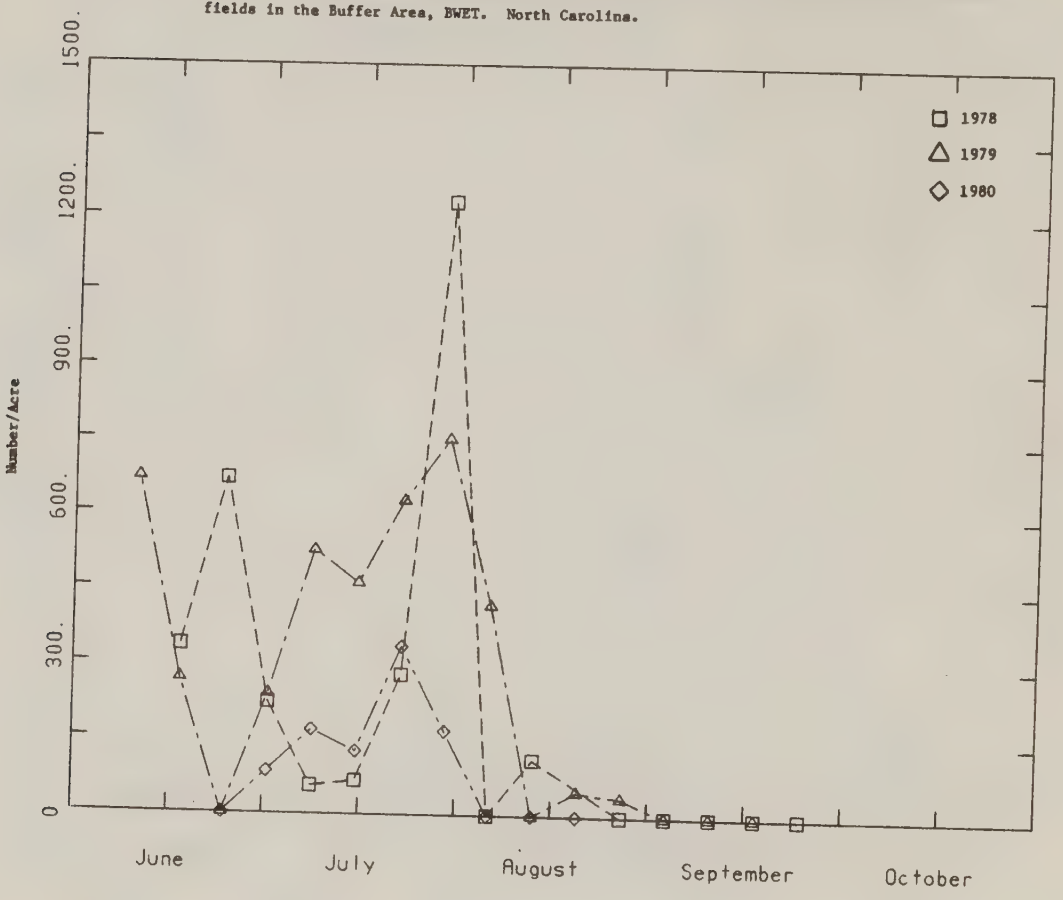


Figure 102. Estimated no. of Chrysopa sp. per acre in 1978, 1979 and 1980 intensively sampled fields in the Buffer Area, BWET. North Carolina.

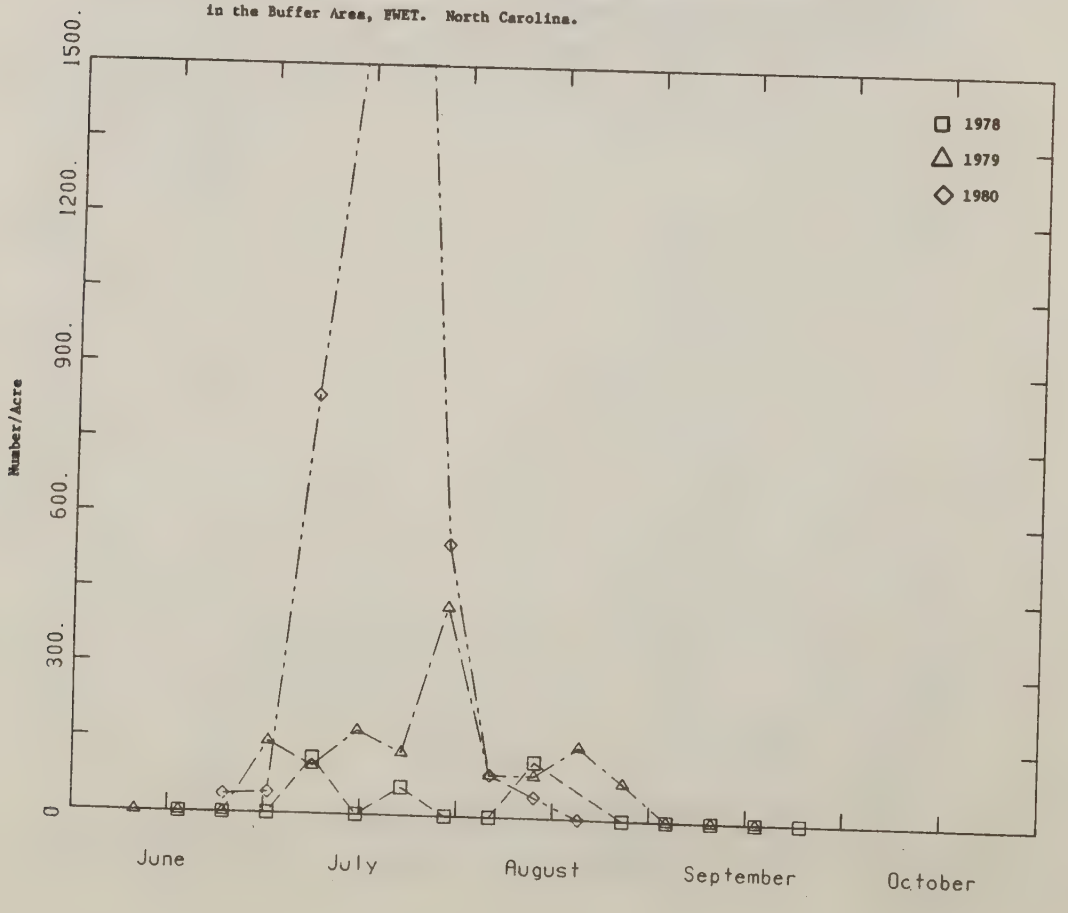


Figure 103. Estimated no. of Nabids per acre in 1978, 1979 and 1980 intensively sampled fields in the Buffer Area, BWET. North Carolina.

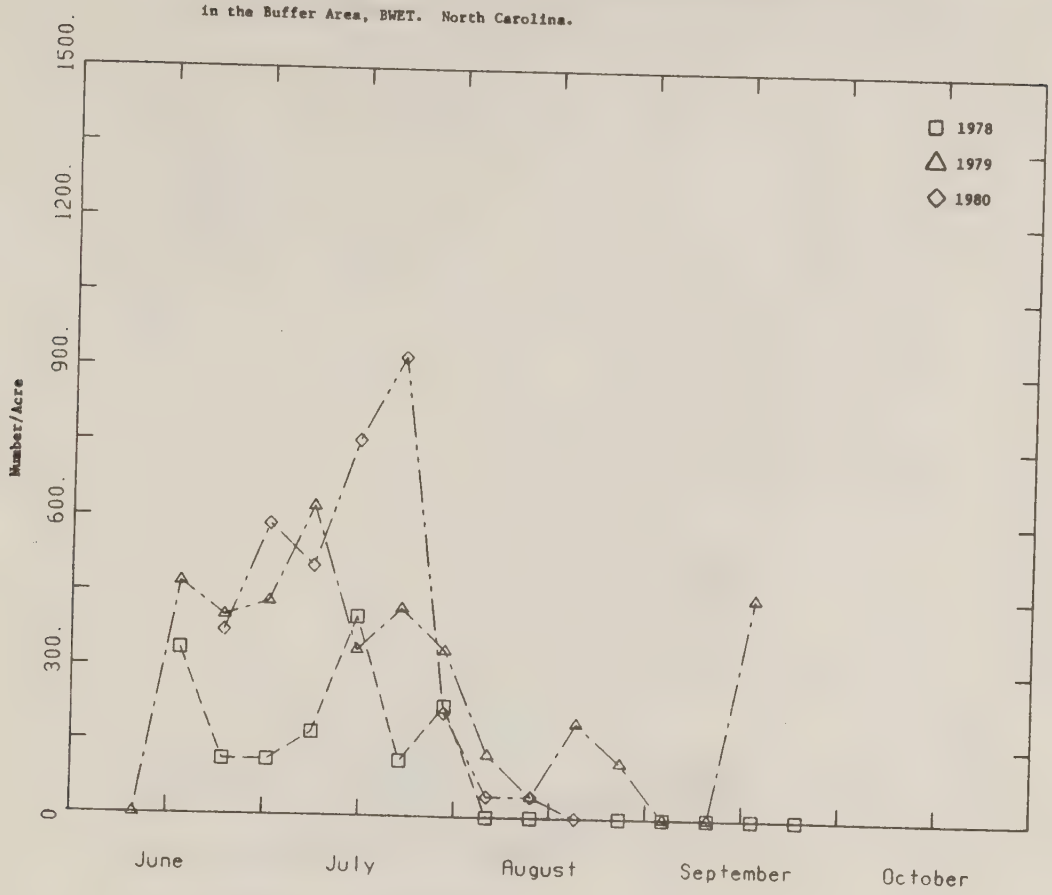


Figure 104. Estimated no. of Lynx spiders per acre in 1978, 1979 and 1980 intensively sampled fields in the Buffer Area, BWET. North Carolina.

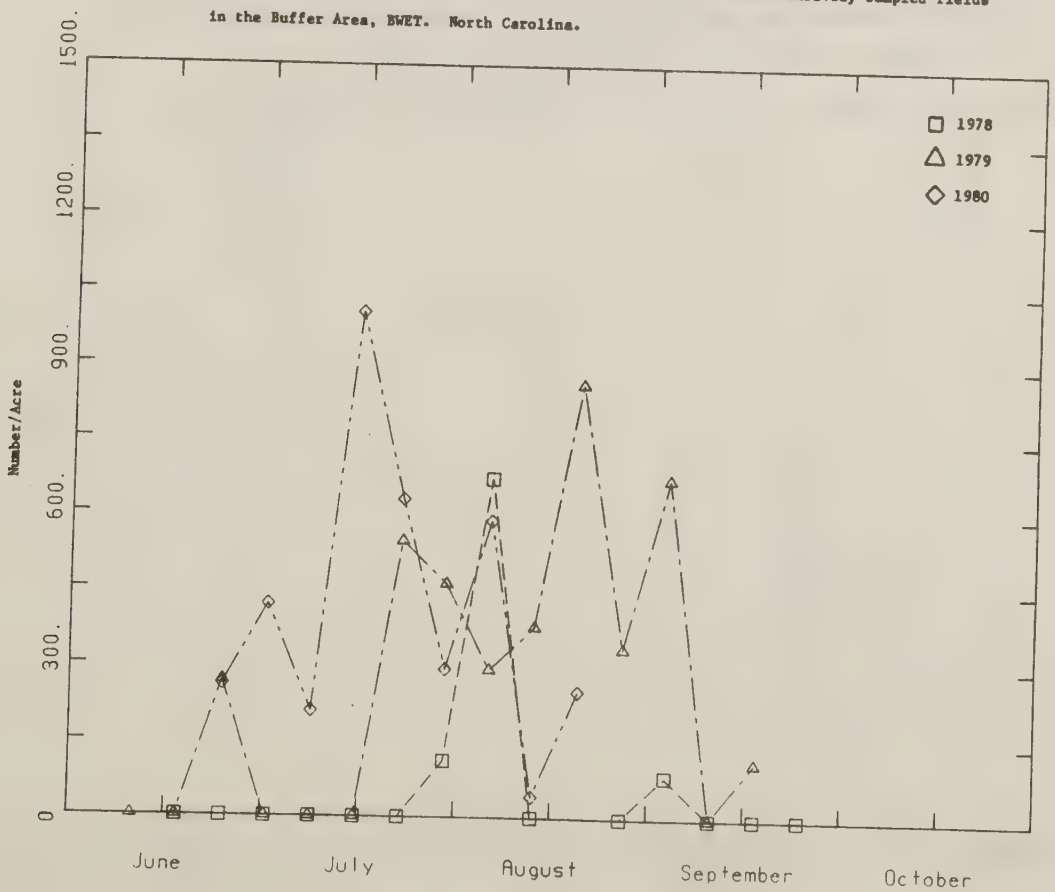


Figure 105. Estimated no. of beneficial insects per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Chowan County, BWET. North Carolina.

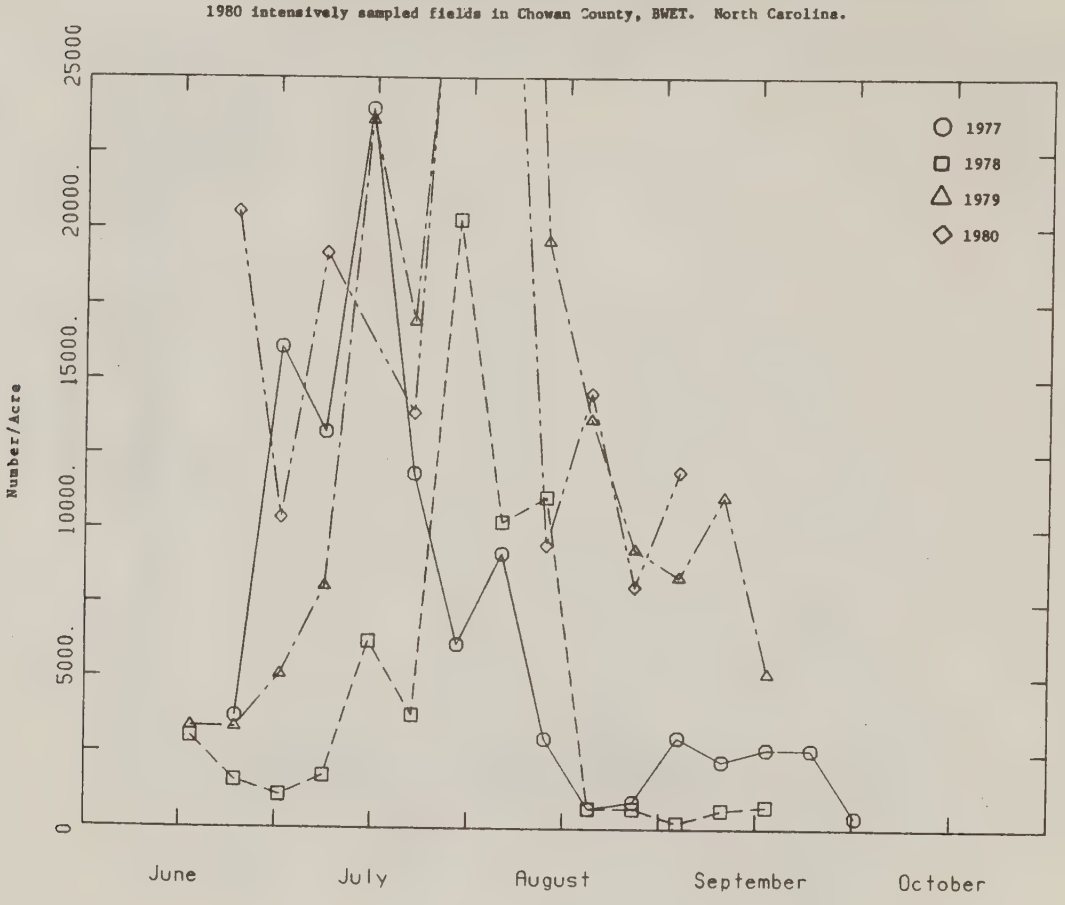


Figure 106. Estimated no. of important beneficial insects per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Chowan County, BWET. North Carolina.

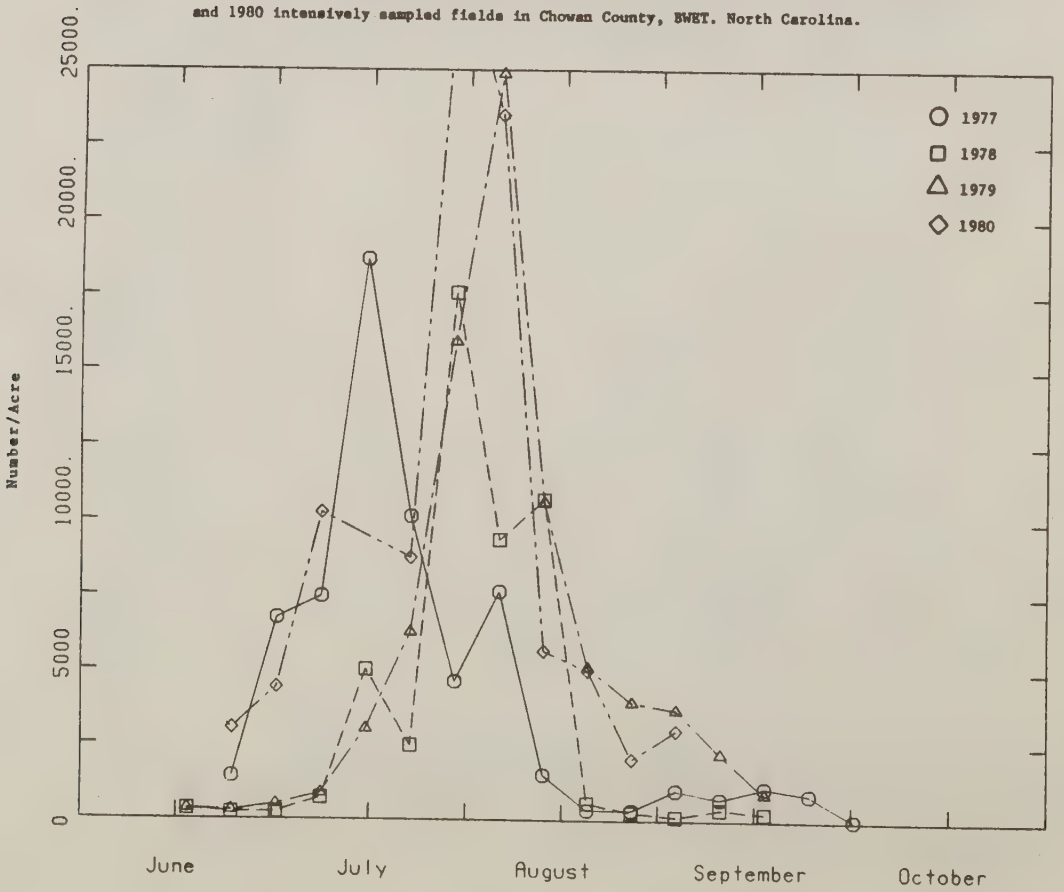


Figure 107. Estimated no. of Geocoris sp. per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Chowan County, BWET. North Carolina.

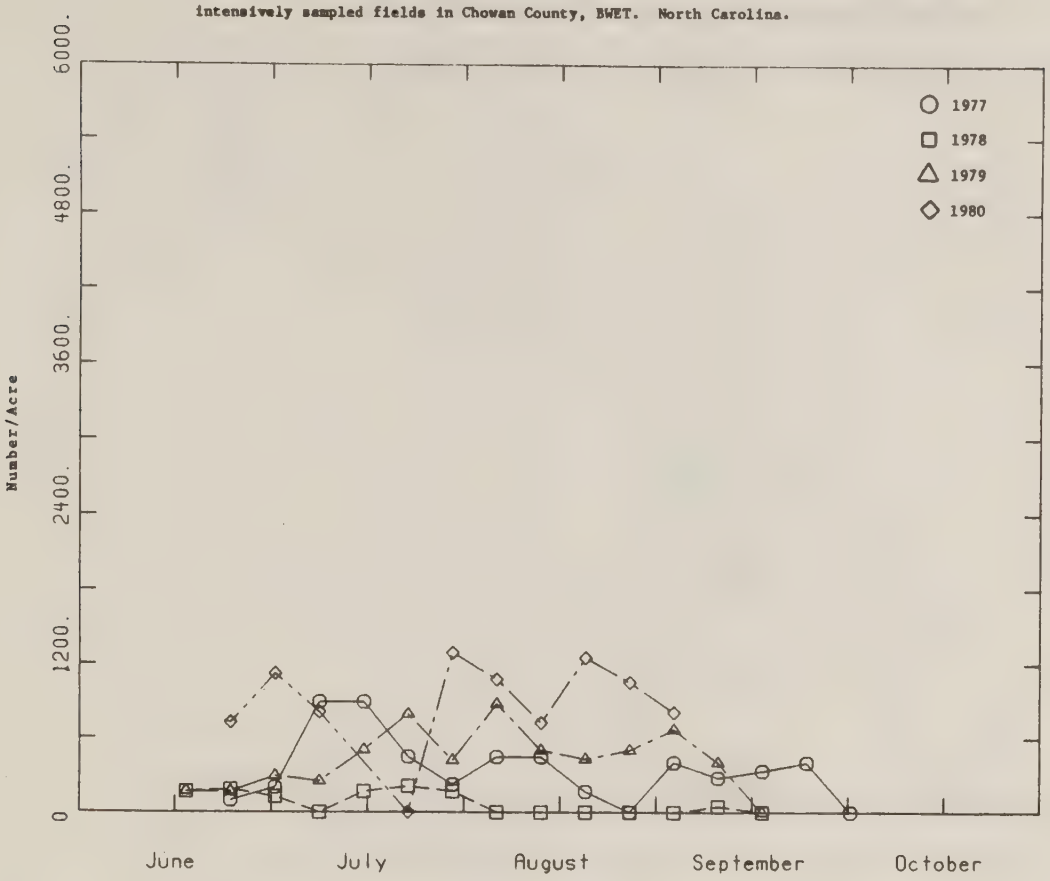


Figure 108. Estimated no. of Orius insidiosus per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Chowan County, BWET. North Carolina.

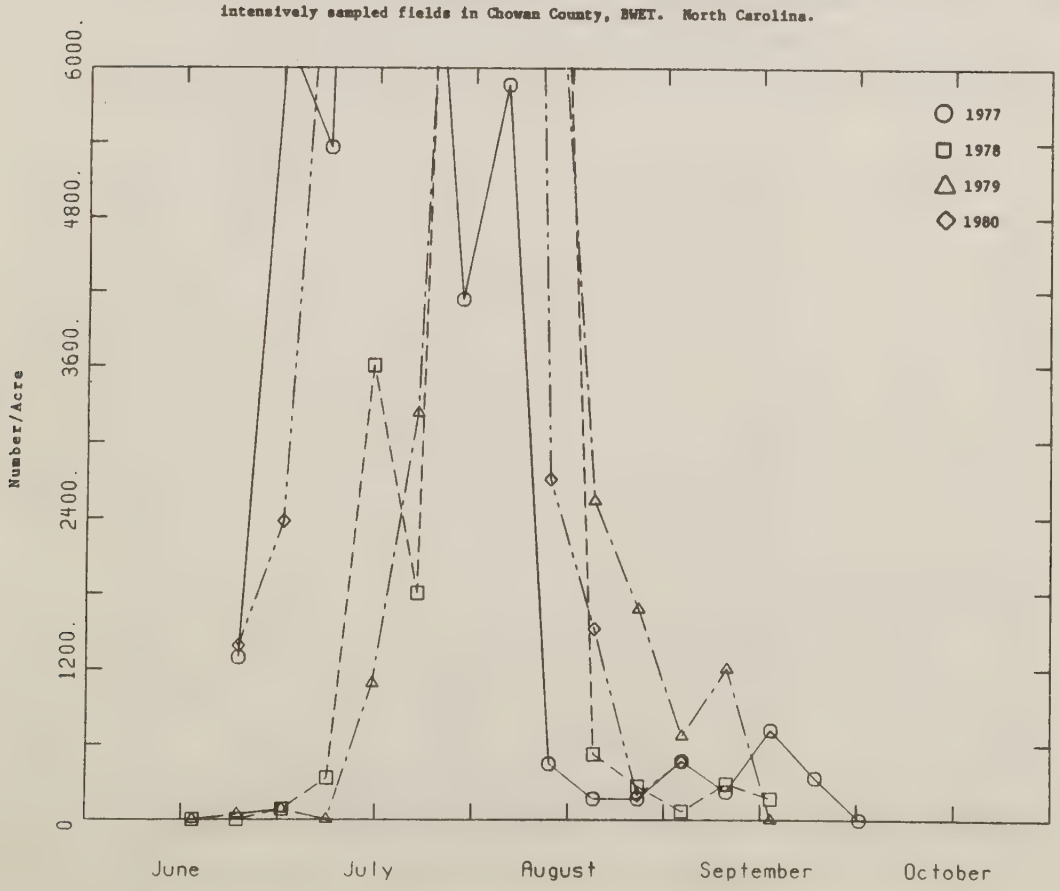


Figure 109. Estimated no. of Hippodomia convergens per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Chowan County, BWET. North Carolina.

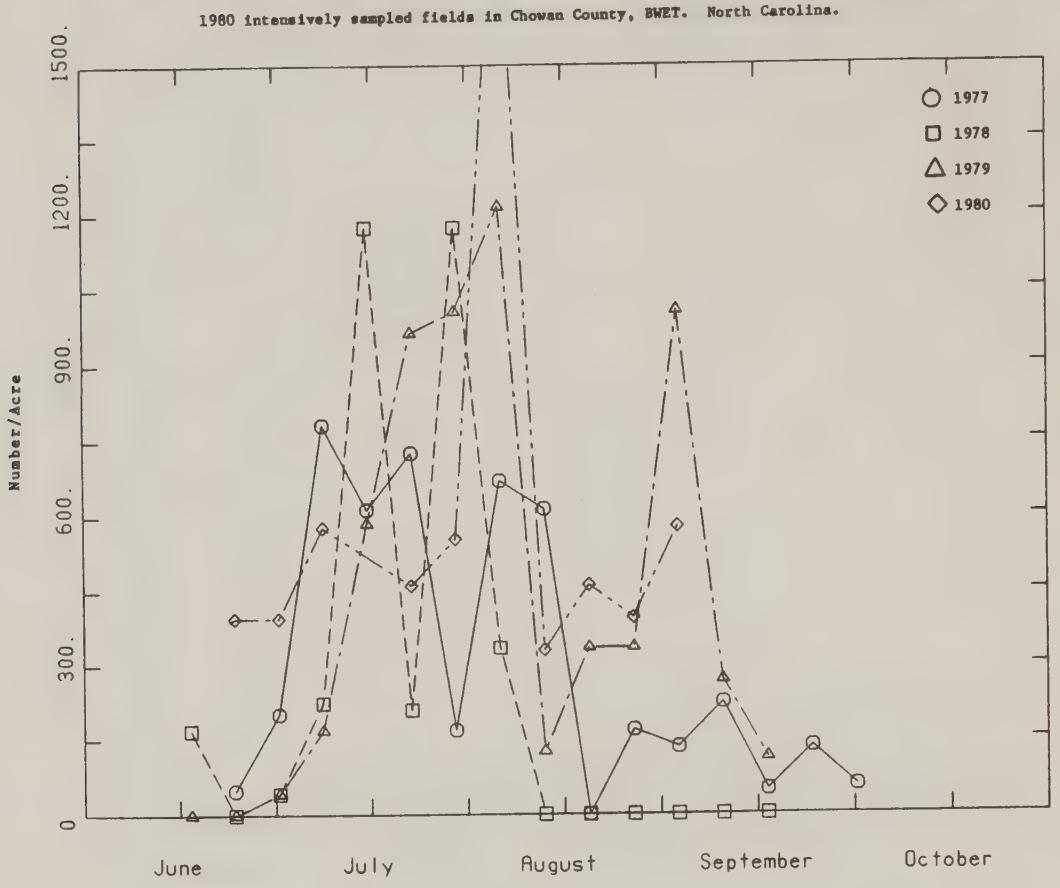


Figure 110. Estimated no. of Coleomegilla maculata per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Chowan County, BWET. North Carolina.

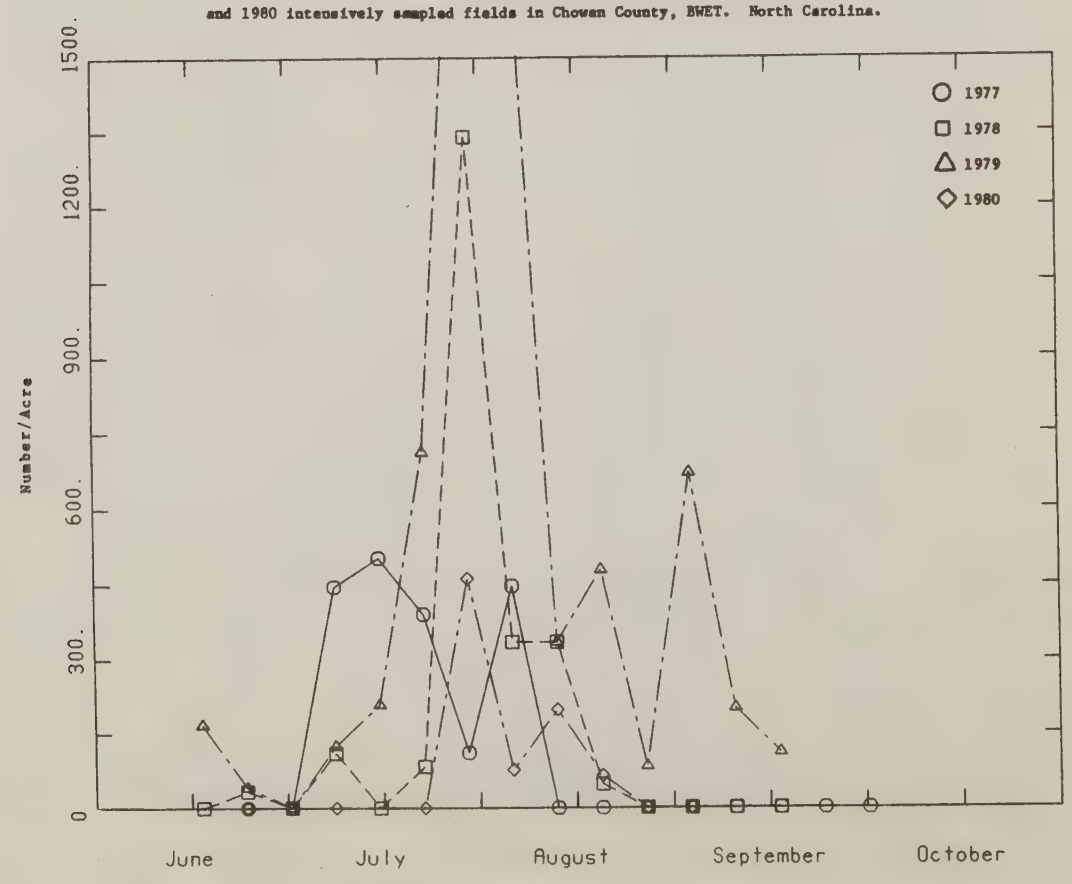


Figure 111. Estimated no. of Chrysopa sp. per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Chowan County, BWET. North Carolina.

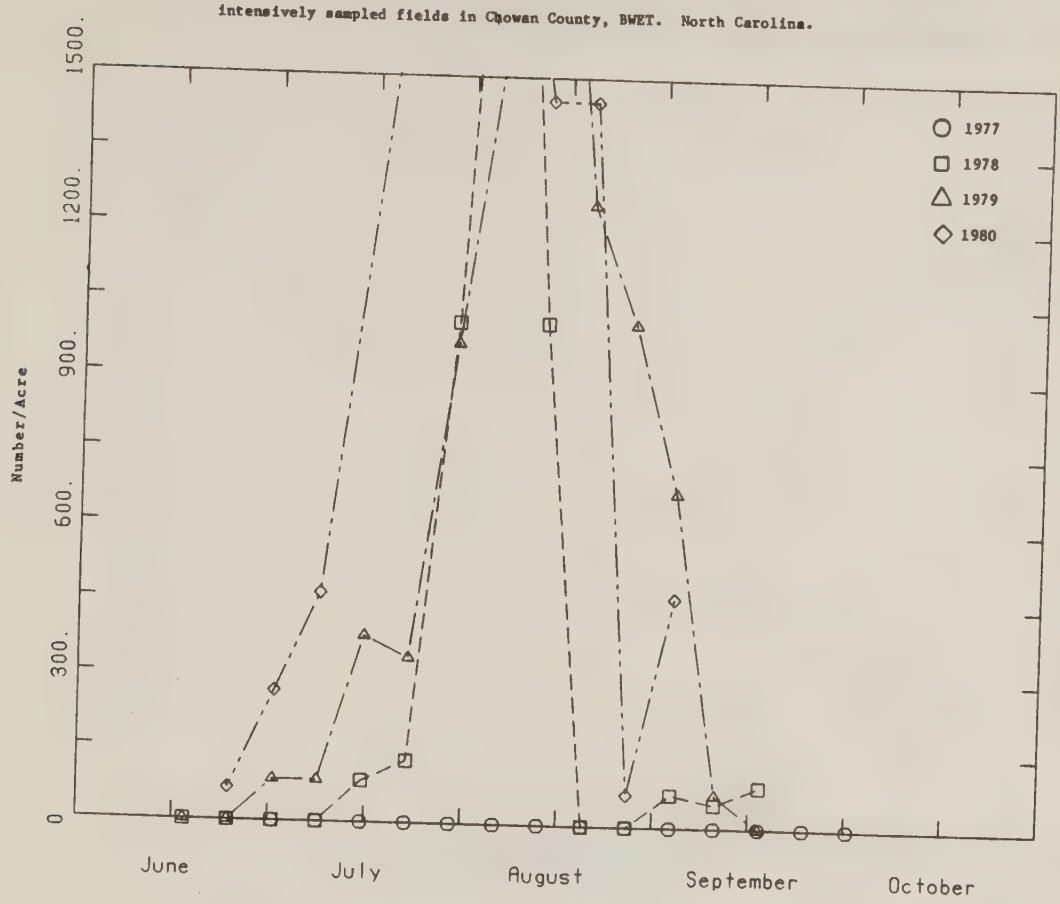


Figure 112. Estimated no. of Nabids per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Chowan County, BWET. North Carolina.

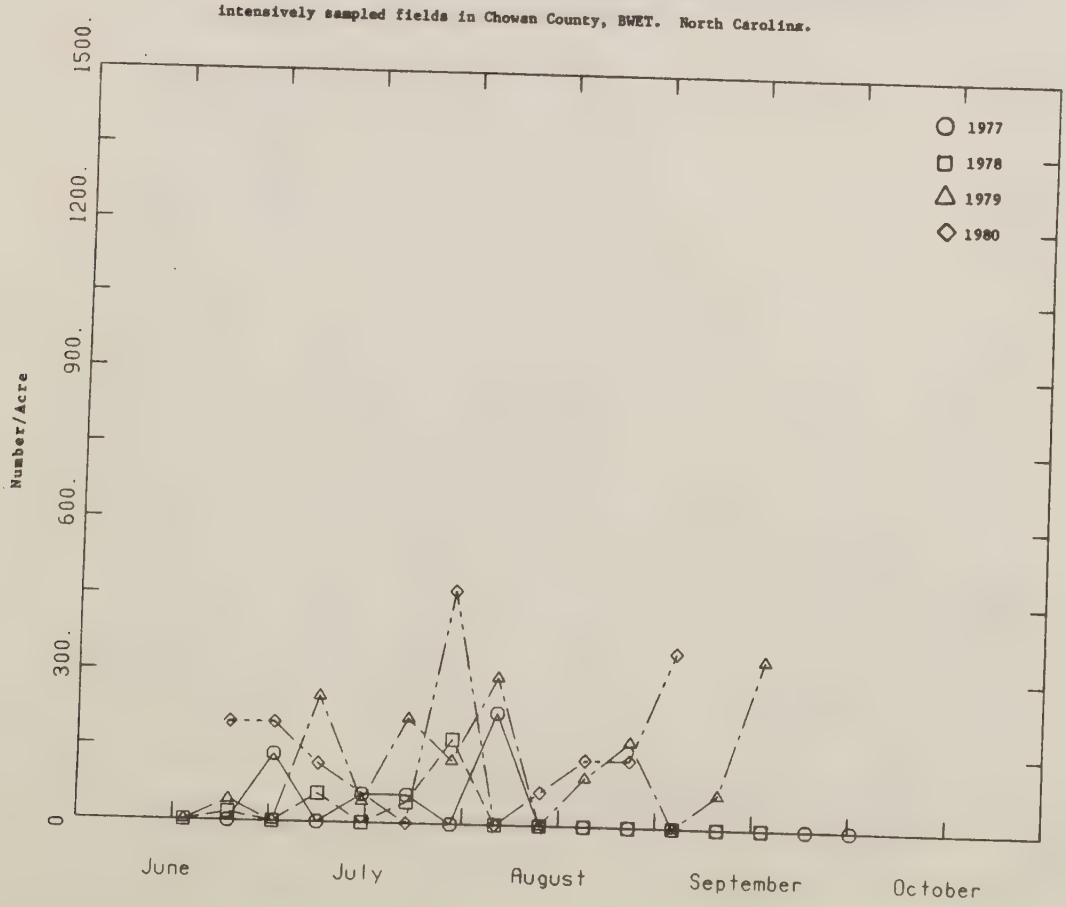


Figure 113. Estimated no. of Lynx spiders per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Chowan County, BWET. North Carolina.

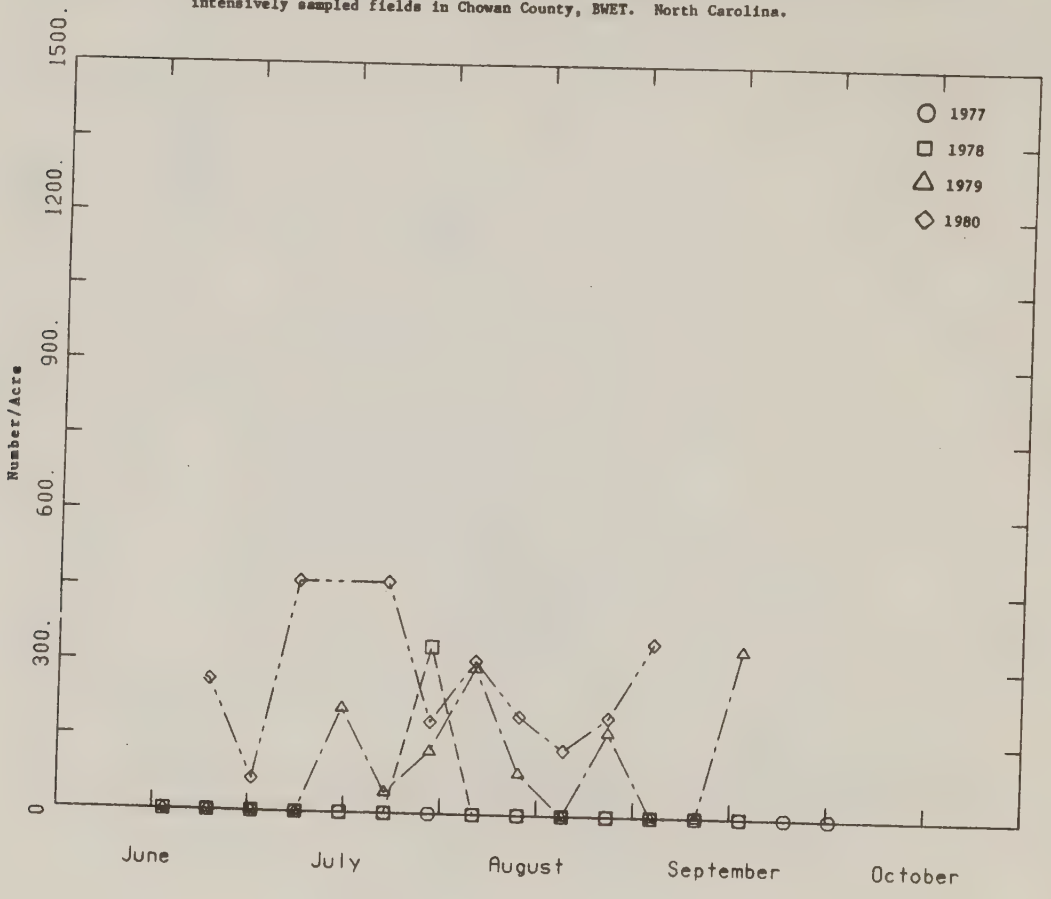


Figure 114. Estimated no. of beneficial insects per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Scotland-Robeson counties outside the BWET area. North Carolina.

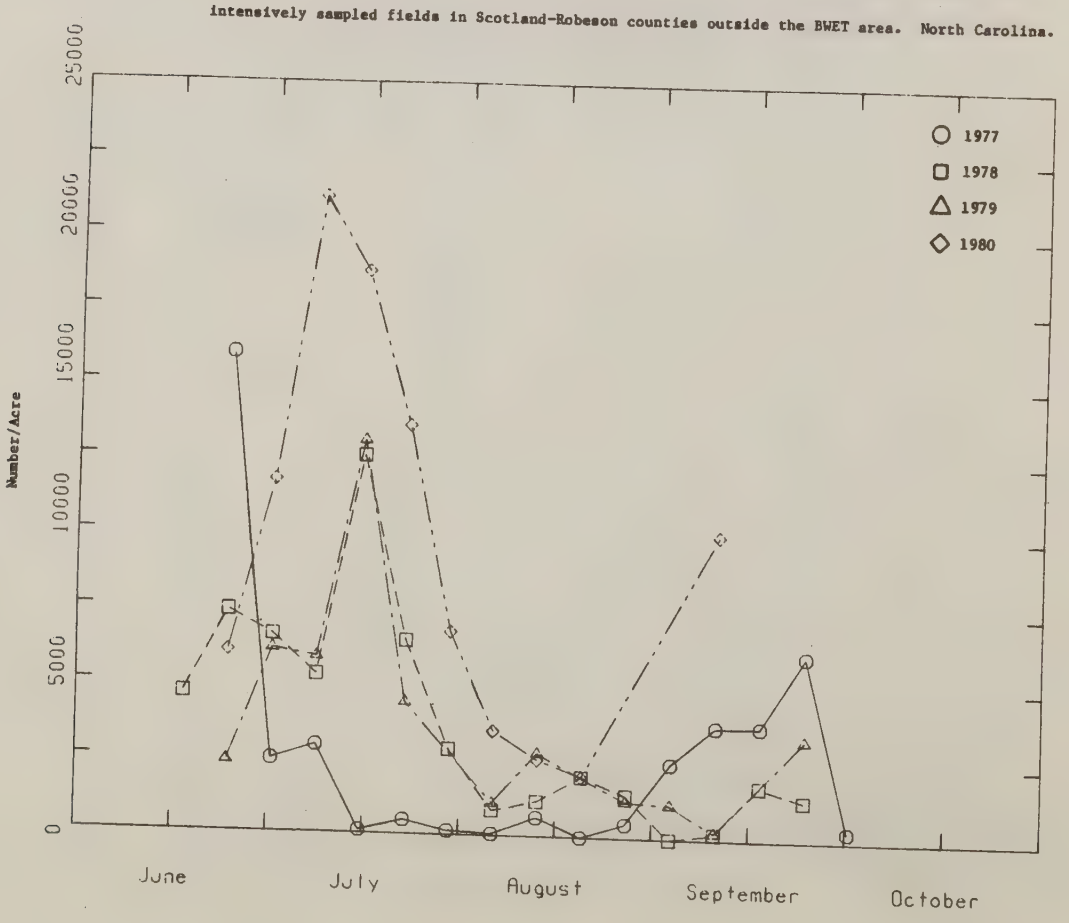


Figure 115. Estimated no. of important beneficial insects per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Scotland-Robeson counties outside the BWET area. North Carolina.

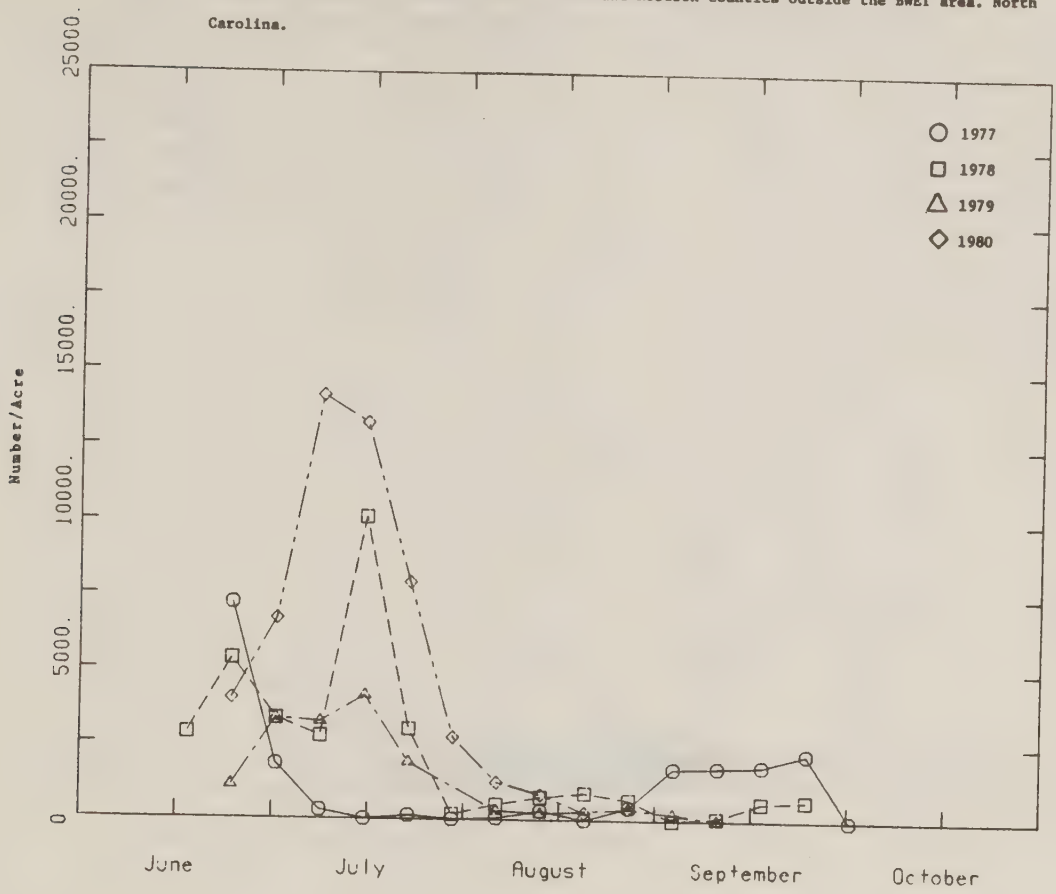


Figure 116. Estimated no. of Geocoris sp. per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Scotland-Robeson counties outside the BWET area. North Carolina.

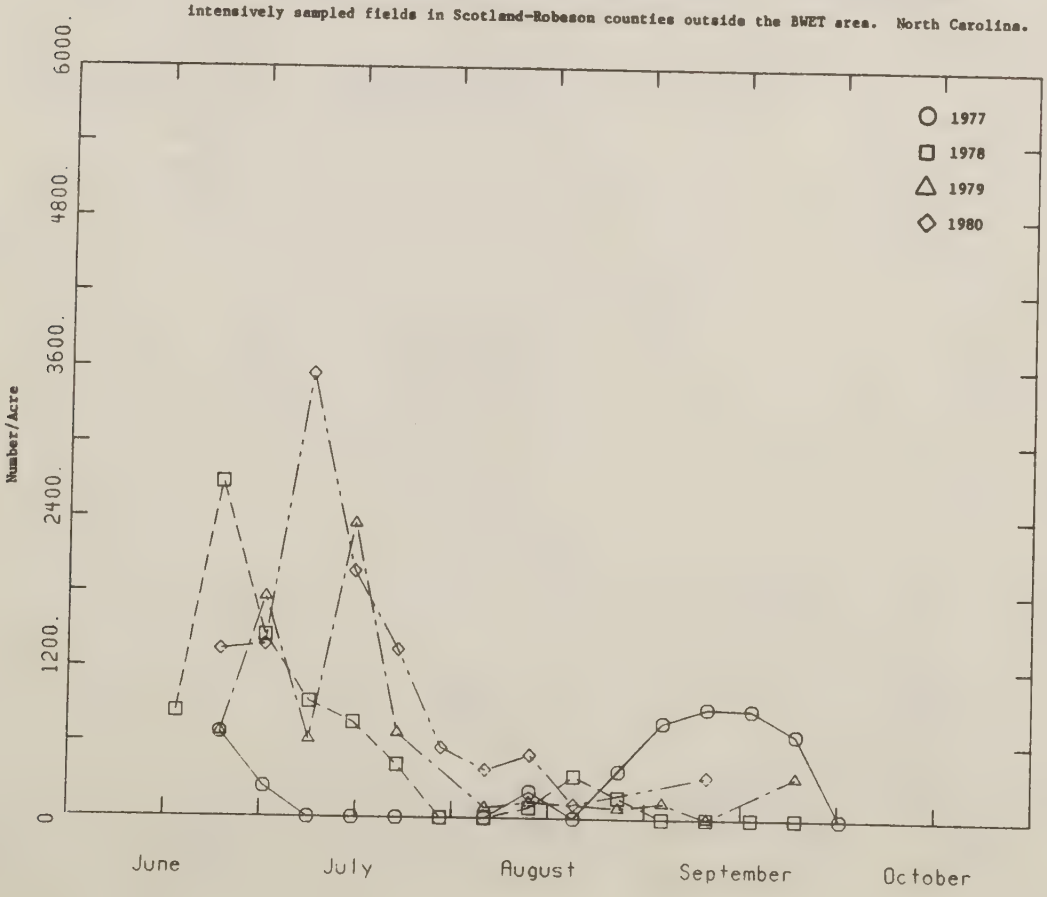


Figure 117. Estimated no. of Orlus insidiosus per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Scotland-Robeson counties outside the BWET area. North Carolina.

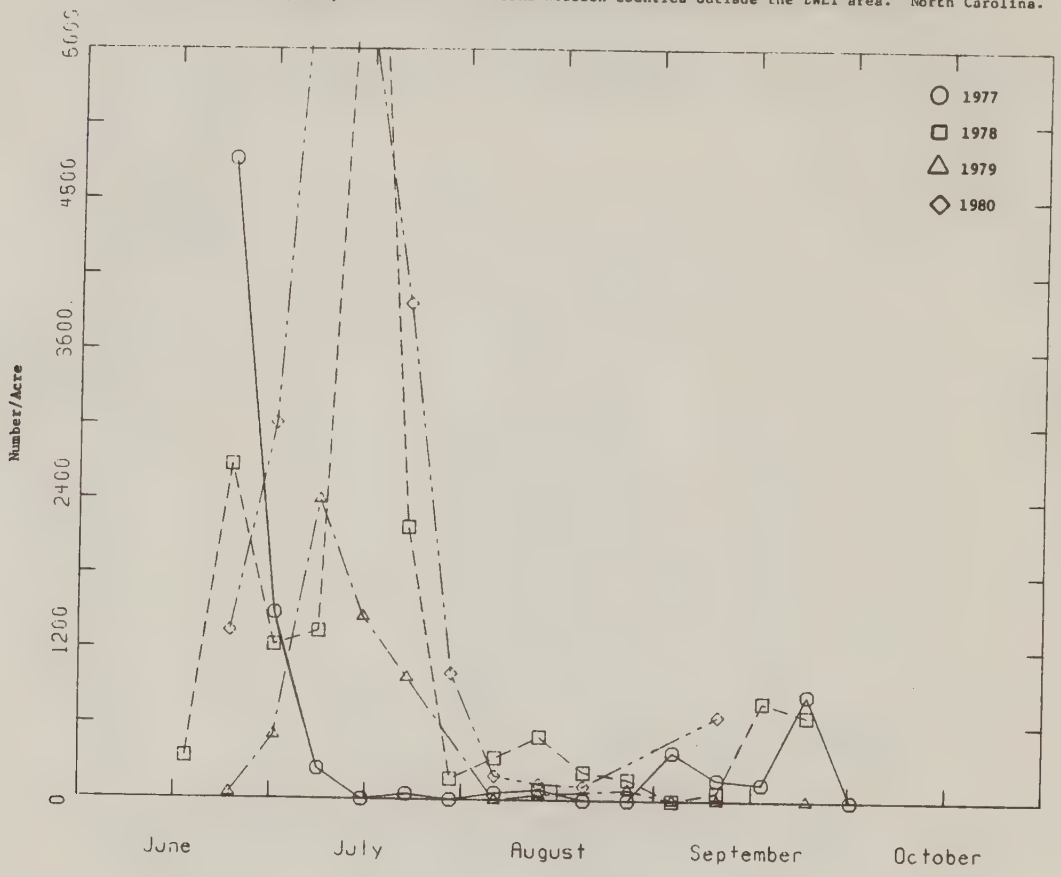


Figure 118. Estimated no. of Hippodamia convergens per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Scotland-Robeson counties outside the BWET area North Carolina.

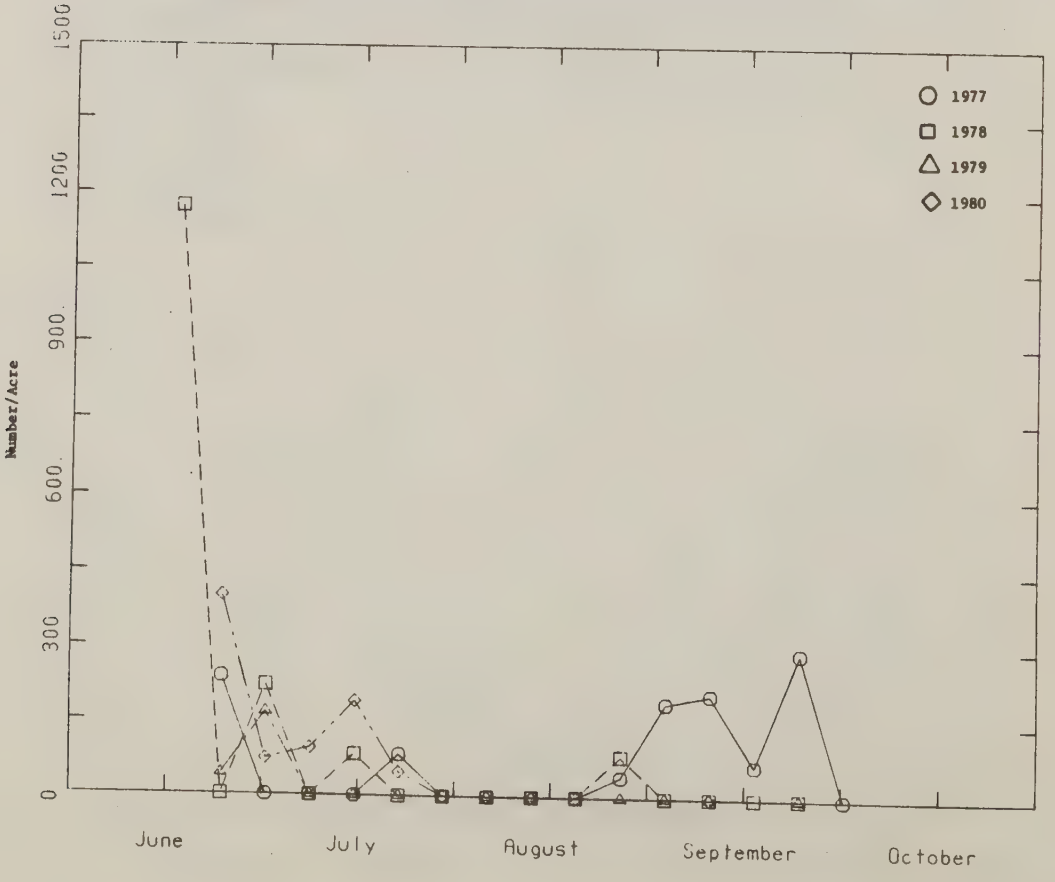


Figure 119. Estimated no of Coleomegilla maculata per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Scotland-Robeson counties outside the BWET area. North Carolina.

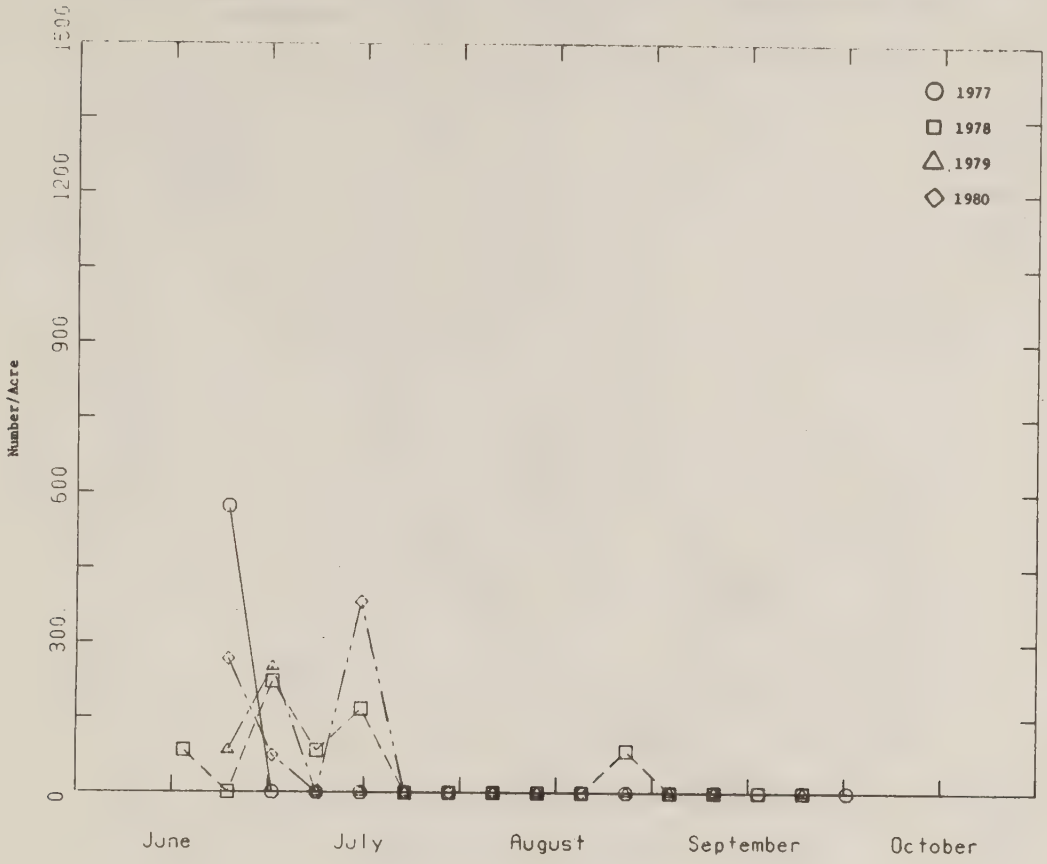


Figure 120. Estimated no. of Chrysopa sp. per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Scotland-Robeson counties outside the BWET area. North Carolina.

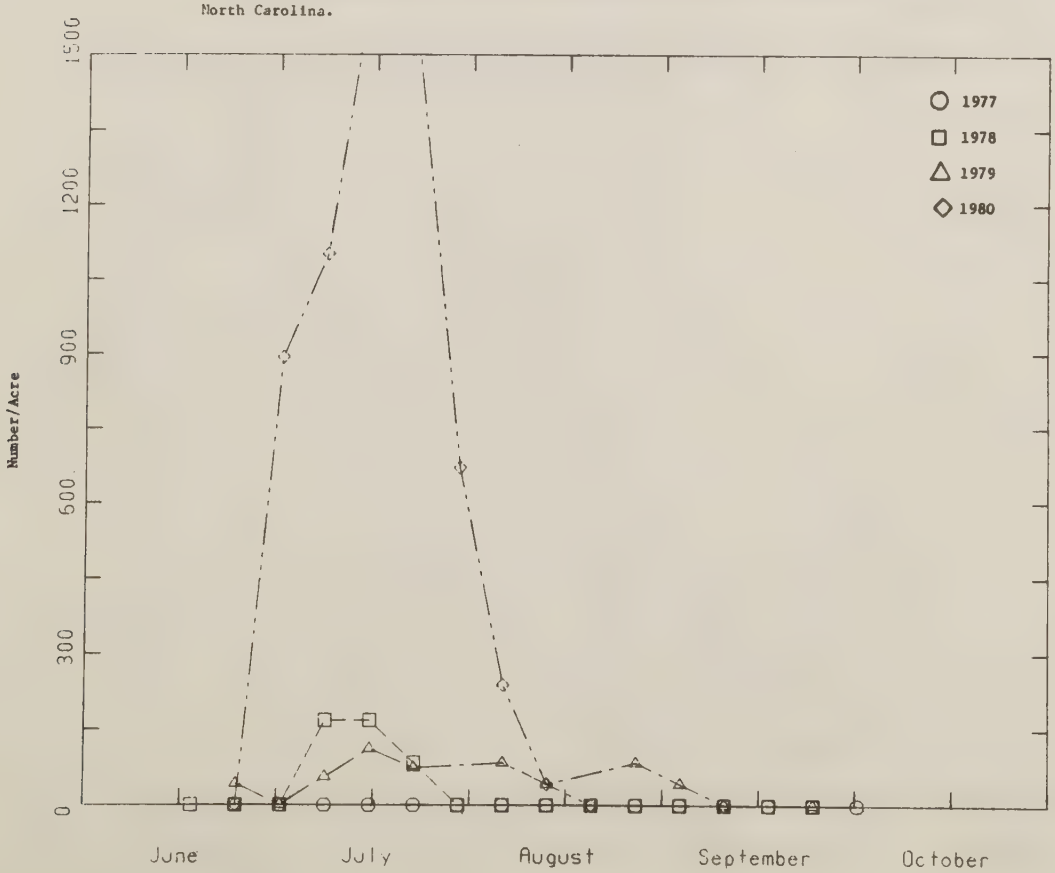


Figure 121. Estimated no. of Nabids per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Scotland-Robeson counties outside the BWET area. North Carolina.

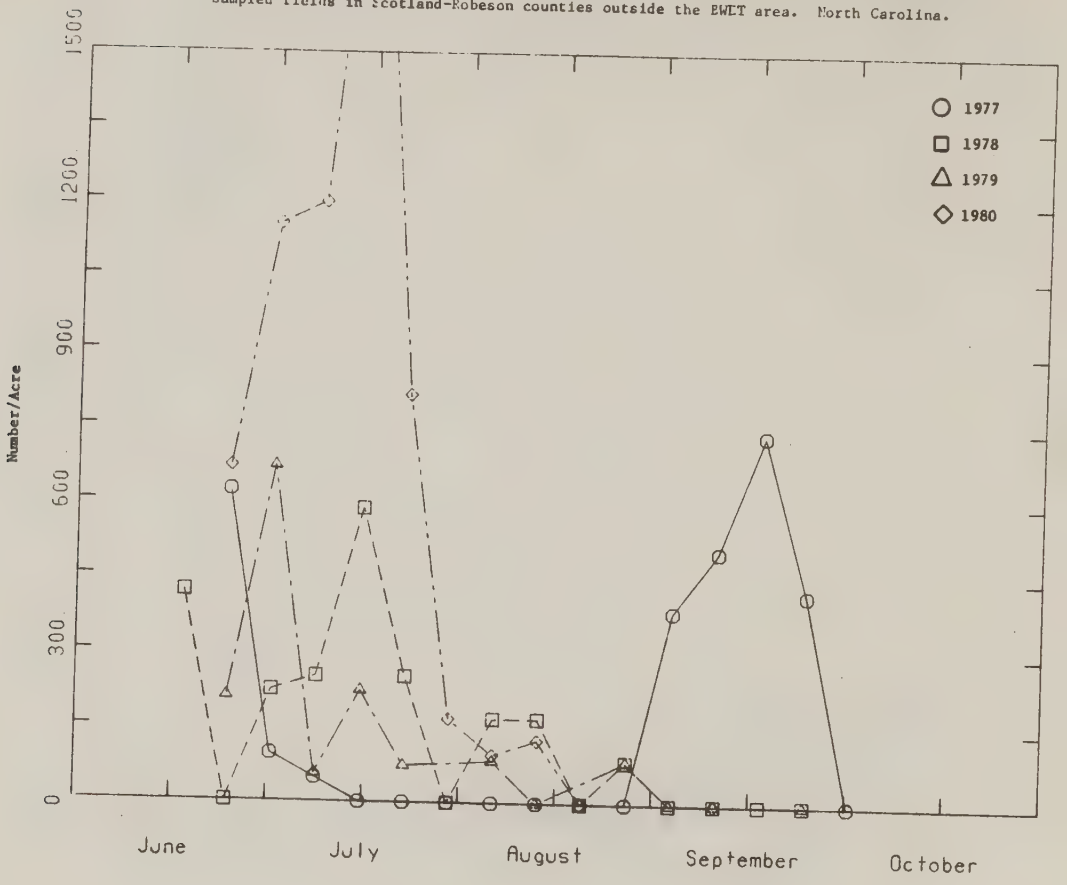


Figure 122. Estimated no. of Lynx spiders per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Scotland-Robeson counties outside the BWET area. North Carolina.

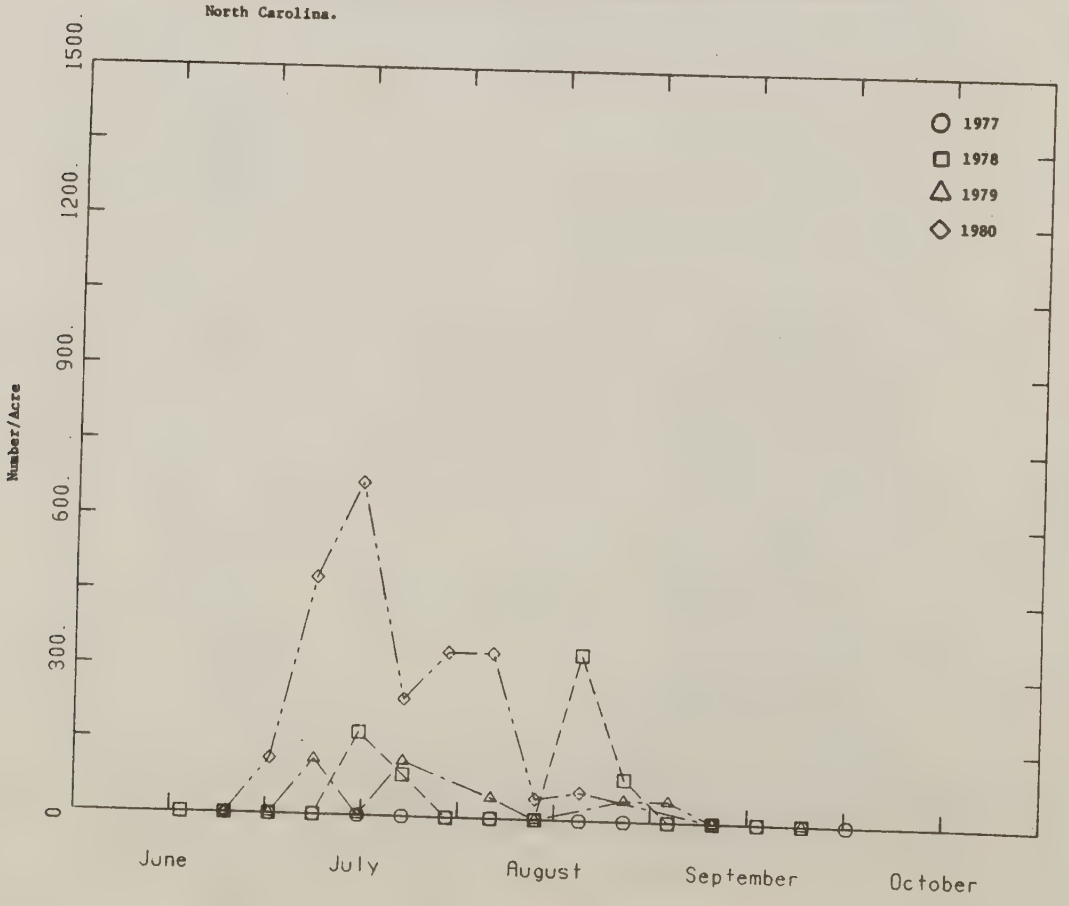


Figure 123. Estimated no. of beneficial insects per acre in 1977 sampled fields and 1978, 1979, and 1980 intensively sampled fields in Cleveland County outside the BWET area. North Carolina.

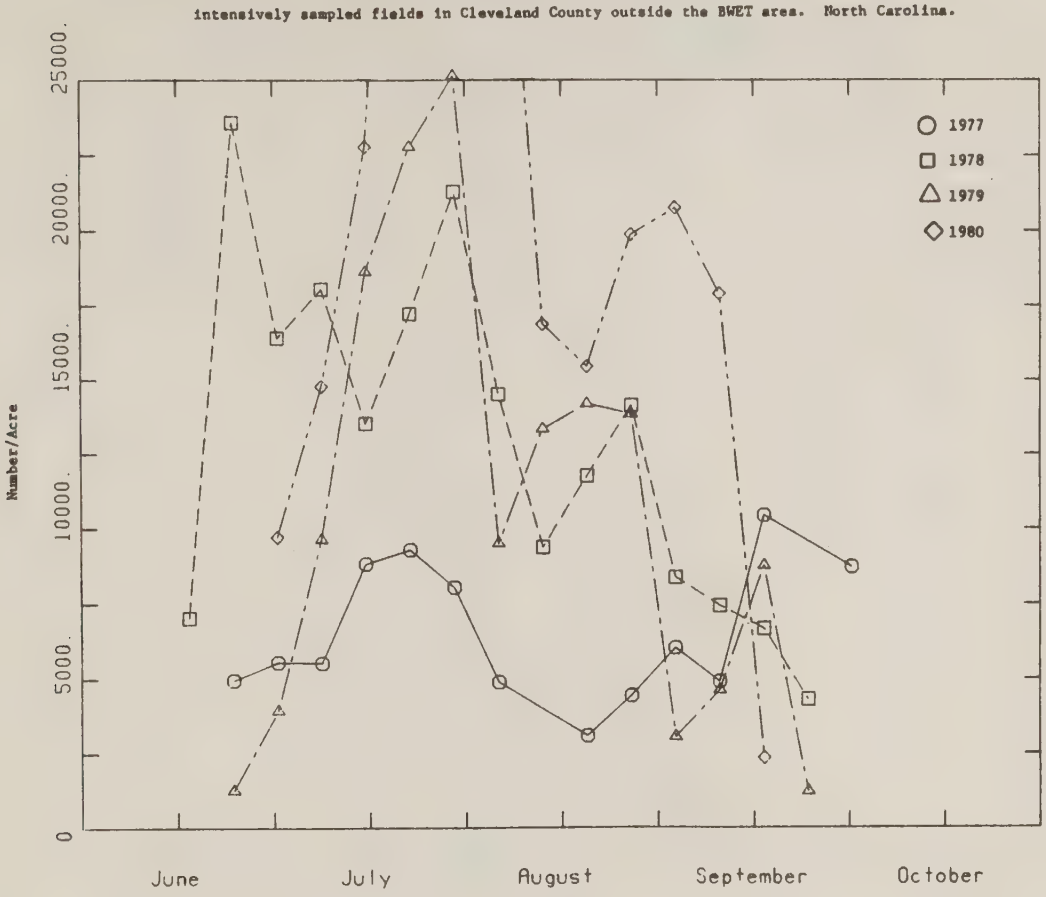


Figure 124. Estimated no. of important beneficial insects per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Cleveland County outside the BWET area. North Carolina.

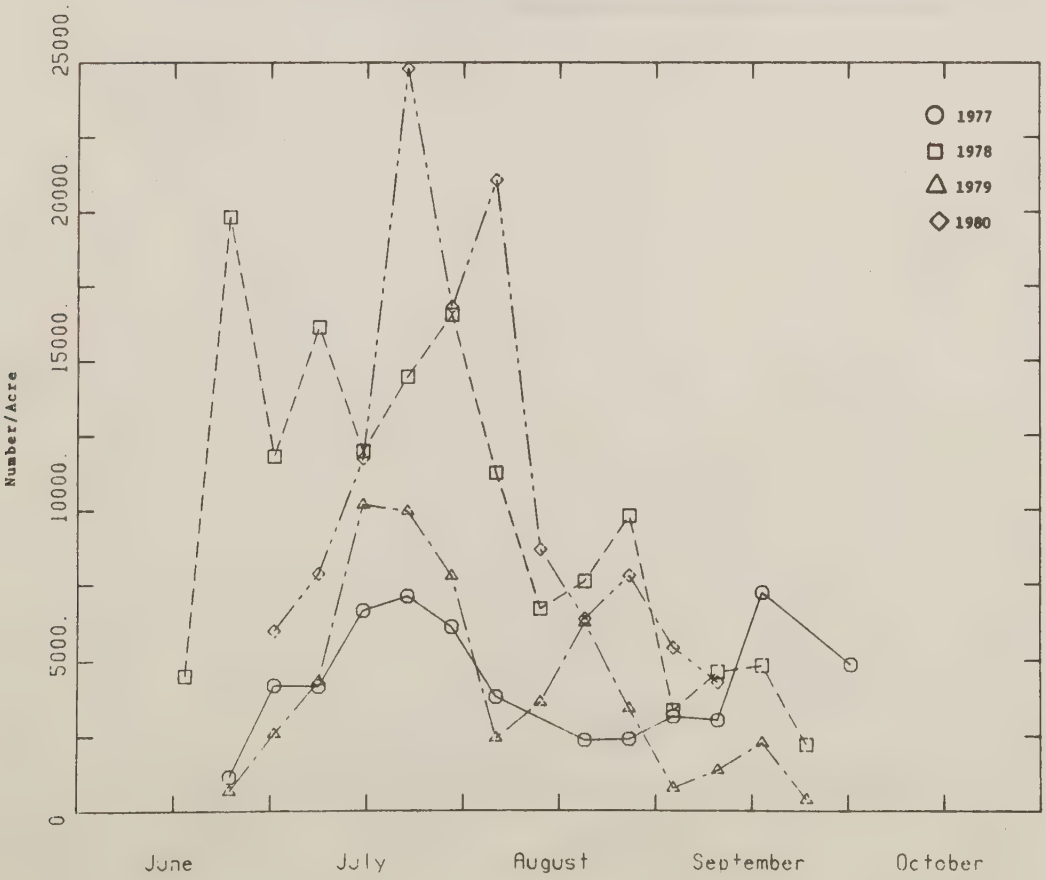


Figure 125. Estimated no. of Geocoris sp. per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Cleveland County outside the BWET area. North Carolina.

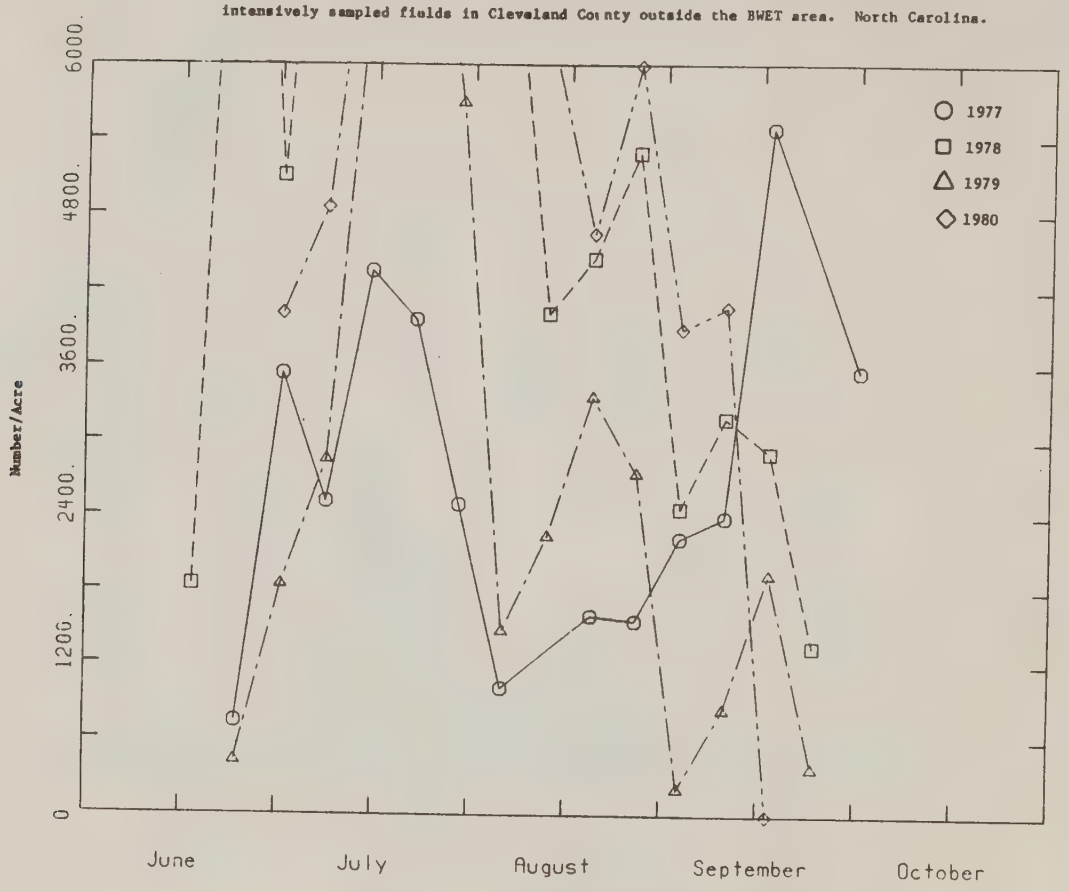


Figure 126. Estimated no. of Orius insidiosus per acre in 1977 sampled fields and 1978, 1979 and 1980 sampled fields in Cleveland County outside the BWET area. North Carolina.

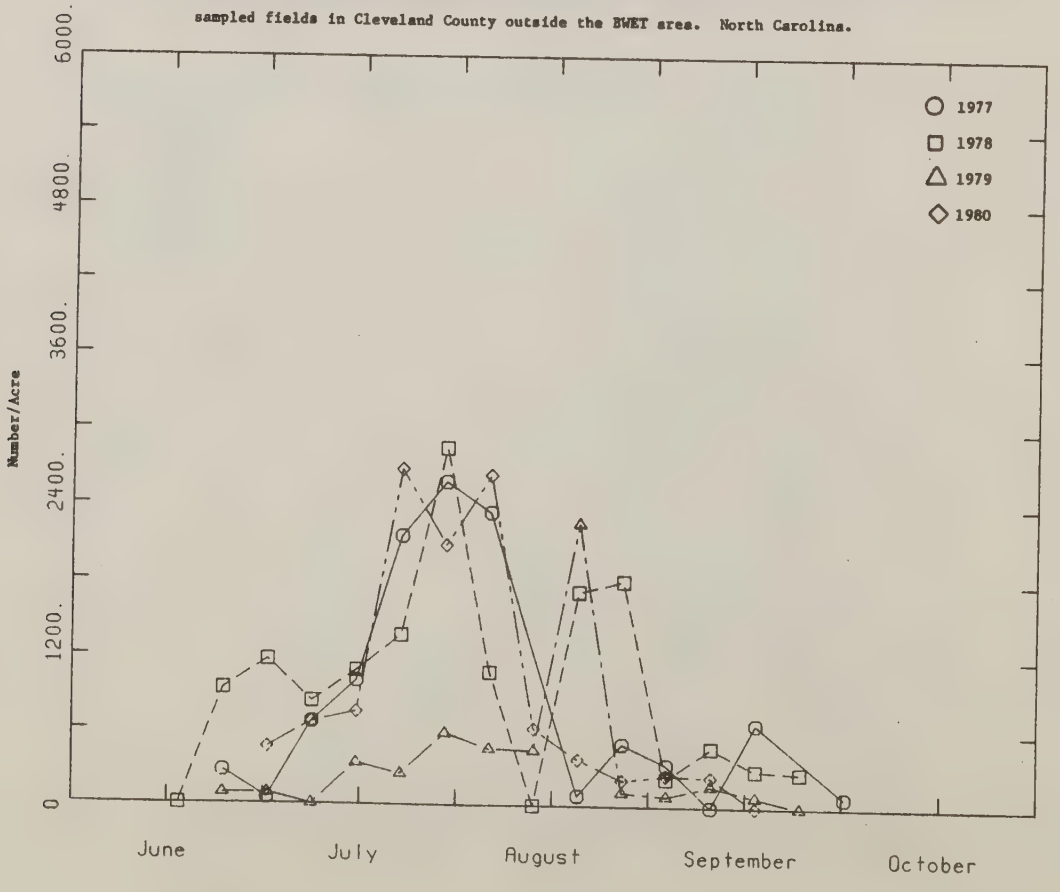


Figure 127. Estimated no. of Hippodamia convergens per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Cleveland County outside the BWET area. North Carolina.

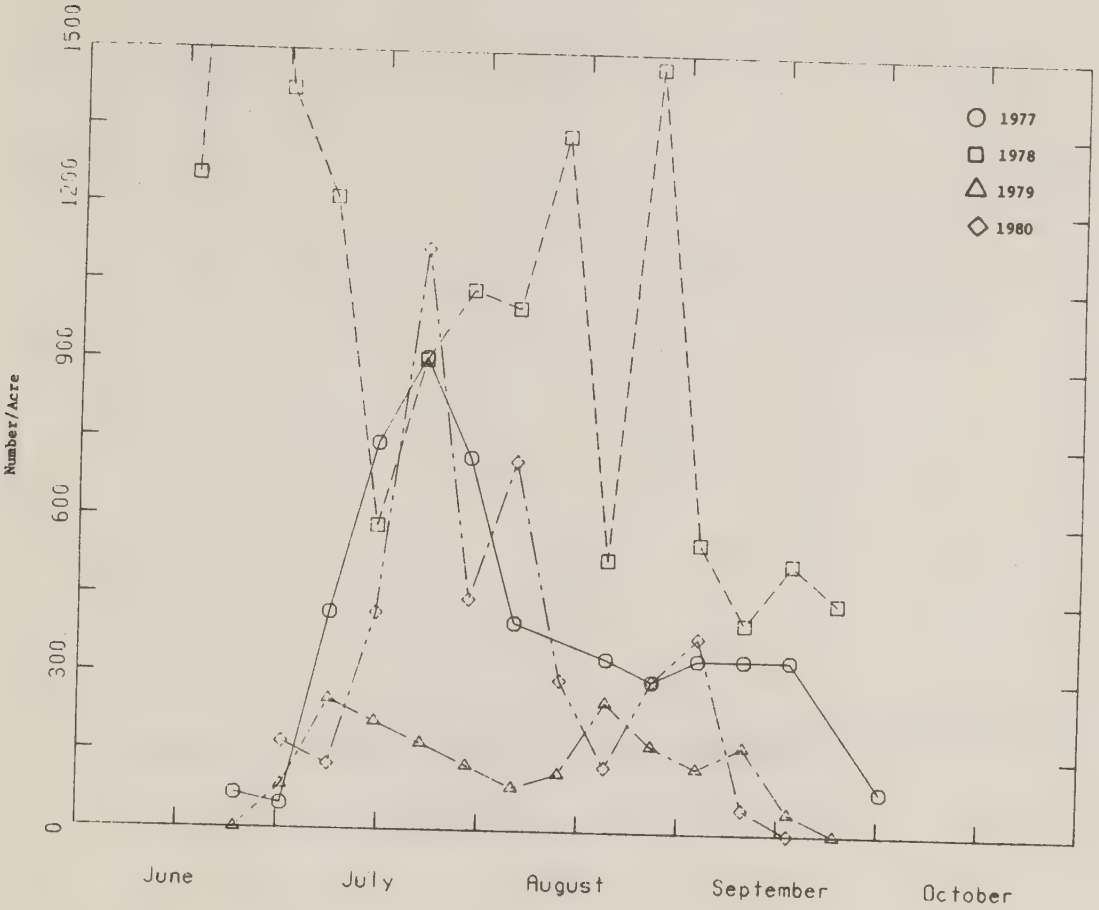


Figure 128. Estimated no of Coleomegilla maculata per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Cleveland County outside the BWET area. North Carolina.

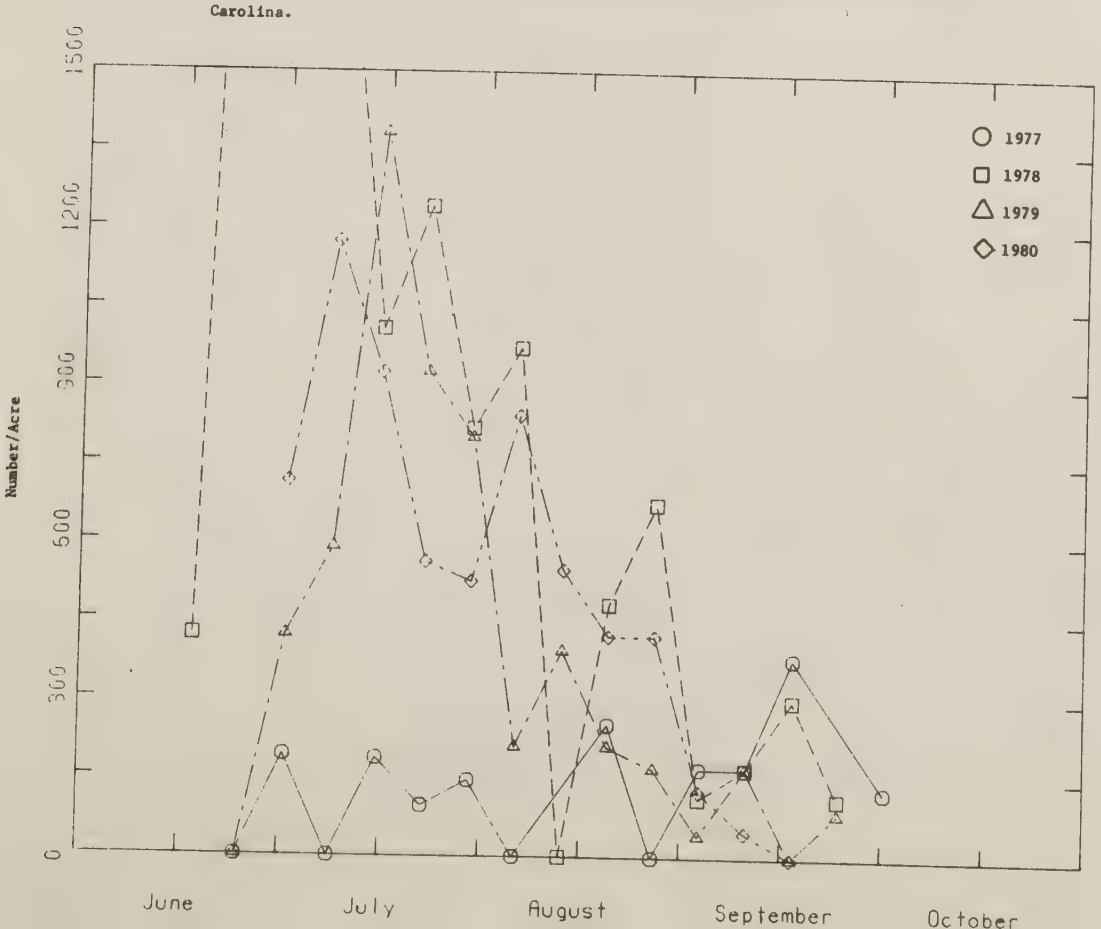


Figure 129. Estimated no. of Chrysopa sp. per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Cleveland County outside the BWET area. North Carolana.

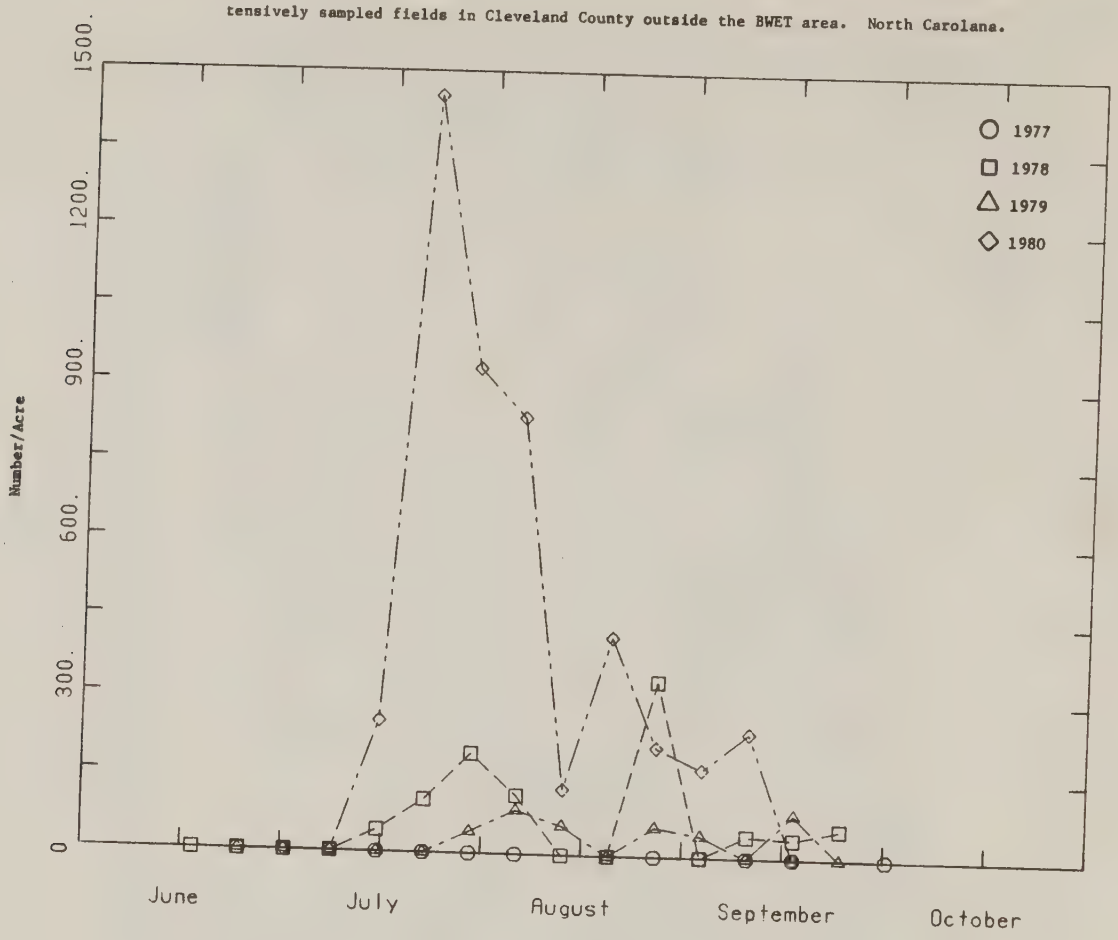


Figure 130. Estimated no of Nabids per acre in 1977 sampled fields and 1978, 1979 and 1980 intensively sampled fields in Cleveland County outside the BWET area. North Carolina.

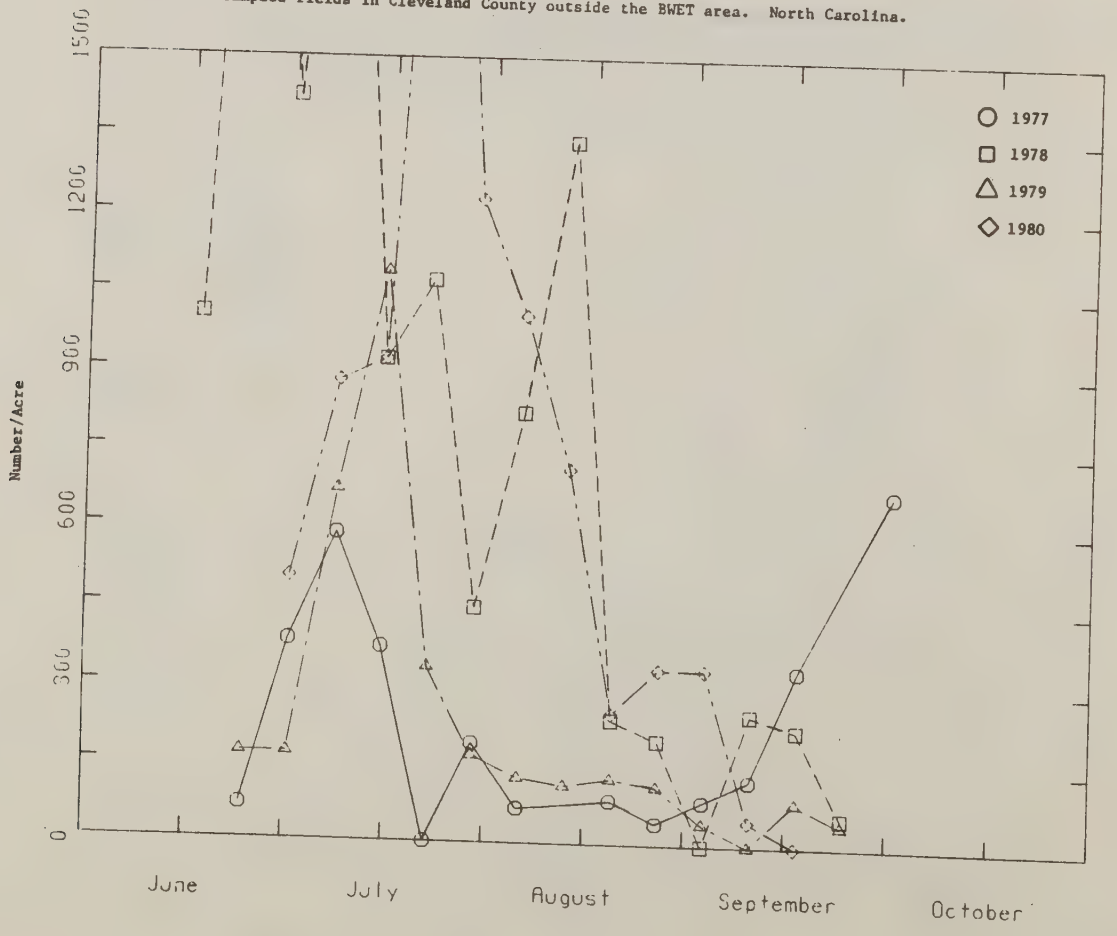


Figure 131. Estimated no. of Lynx spiders per acre in 1977 sampled fields and 1978, 1979 afd 1980 intensively sampled fields in Cleveland County outside the EWET area. North Carolina.

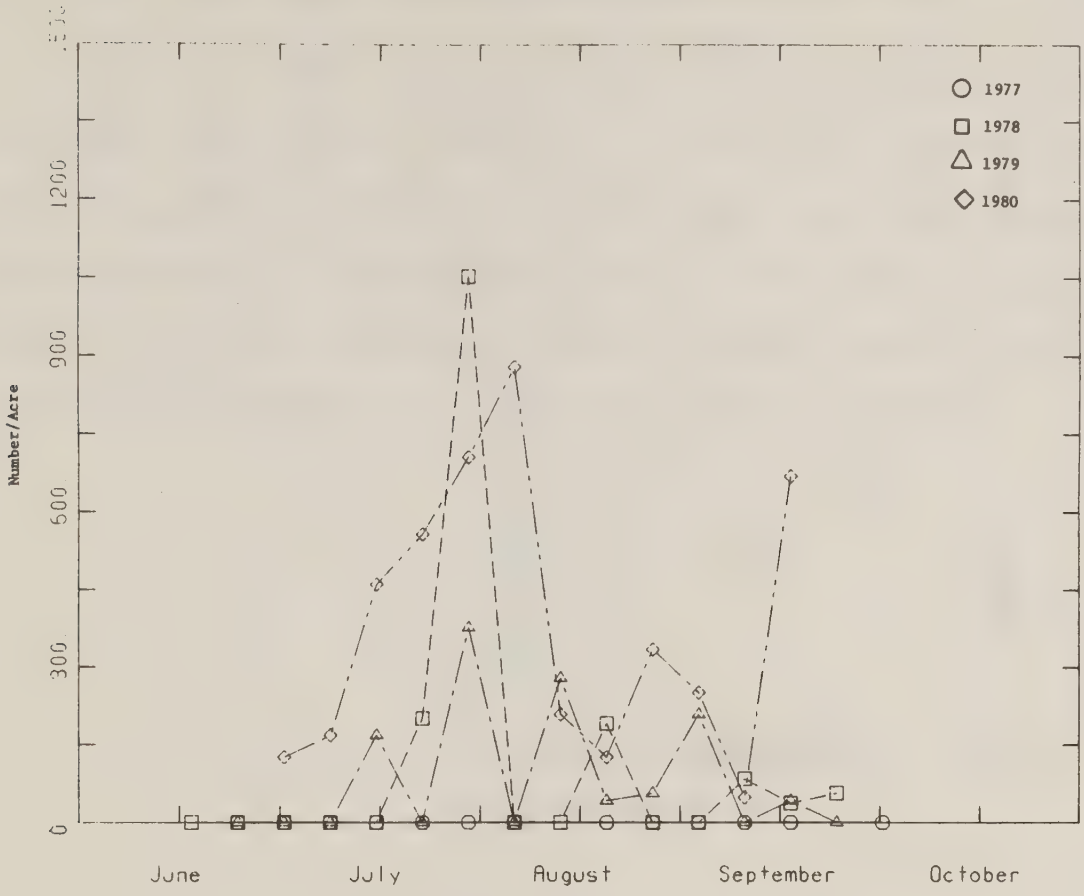


Figure 132. Total no. of boll weevils captured in relation to distance from the north end of the combined east and west trap line. BWET. North Carolina. 1978,1979, and 1980.

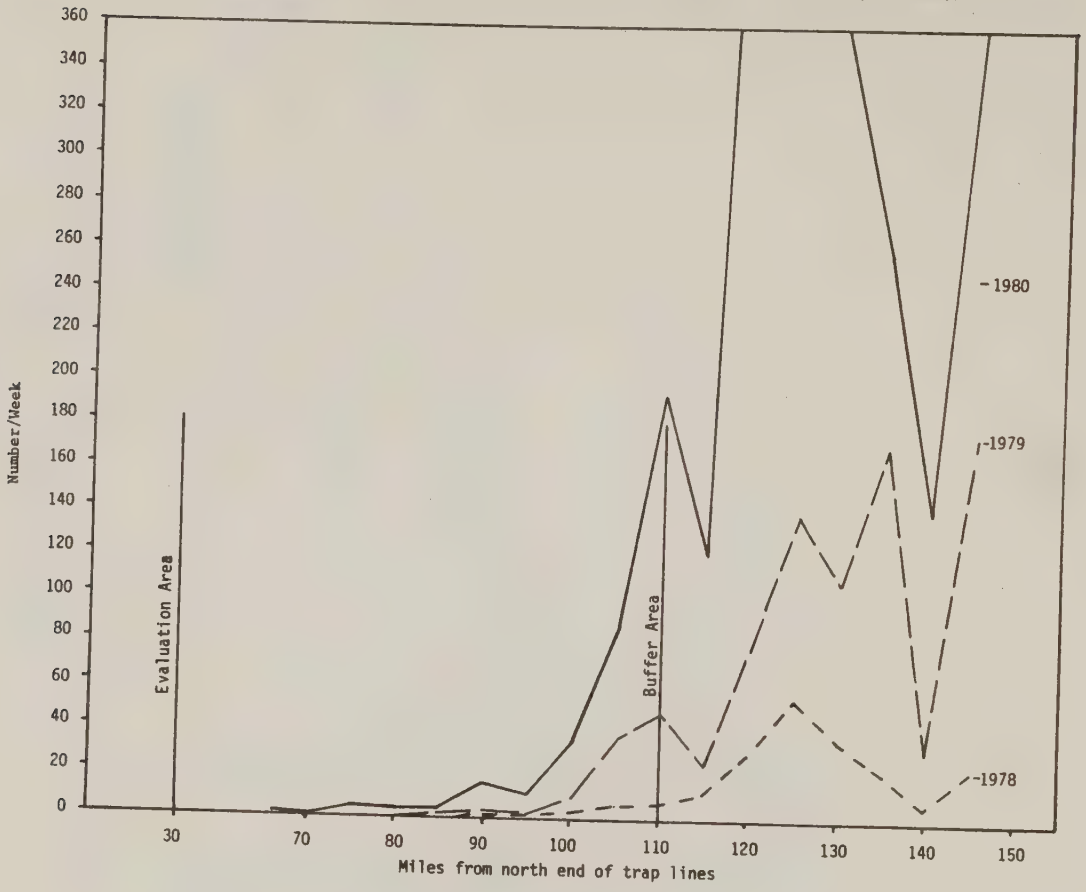
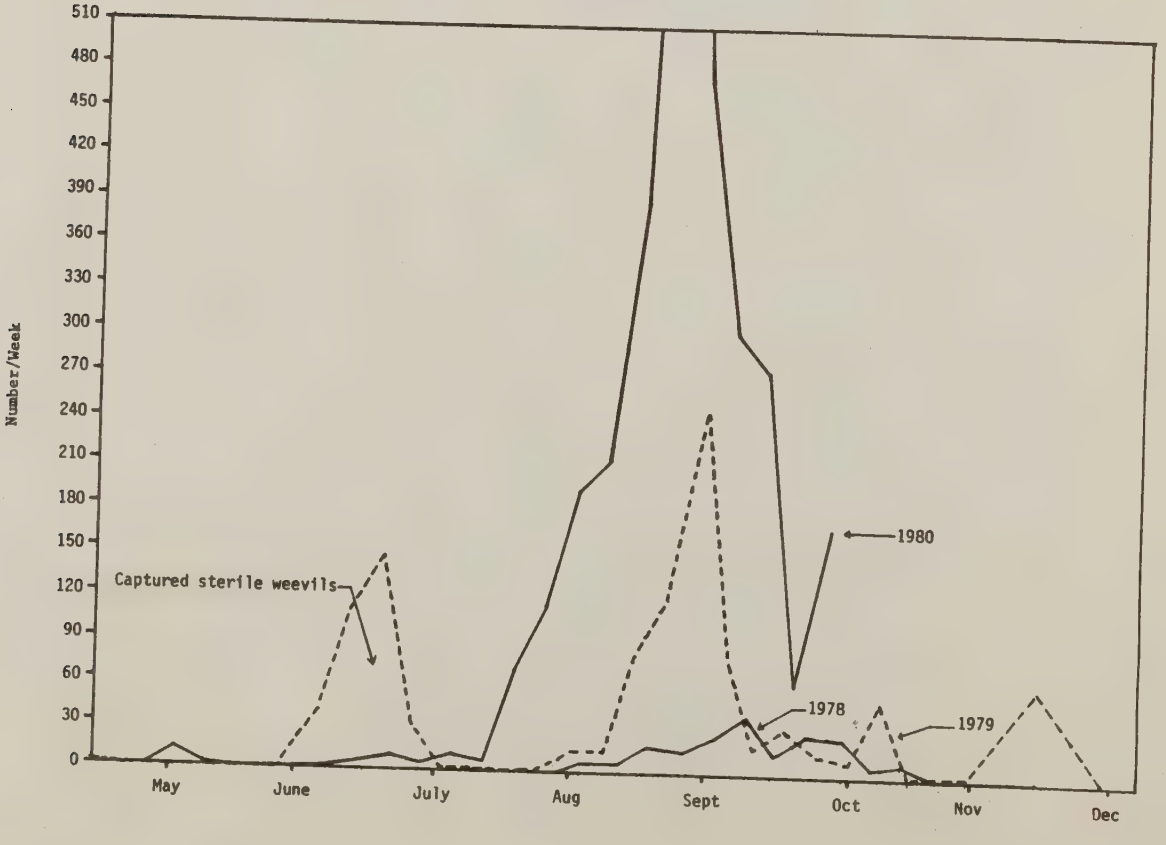


Figure 133. Total no. of boll weevils captured per week in trap lines (eastern and western combined). BWET. North Carolina. 1978, 1979, and 1980.



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